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REINFORCED CONCRETE ARCH BRIDGE AT PLAYA DEL REY, CALIFORNIA.

A good example of graceful arch work in bridge construction is furnished by the illustration on this page of the reinforced concrete arch built at Playa del Rey, Cal., for the Los Angeles Pacific R. R. Co. This bridge gives access from the mainland across a lagoon to the beach, and is 205 ft. 8 ins. long over all, with a clear span of 146 ft., having a rise of 18 ft. The bridge is a ribbed arch with hollow abutments founded on piles. There are three arch ribs each 14 ins. thick, and these are connected by eleven cross-beams each 6 ins. thick. The ribs and cross-beams carry a 4-in. slab floor. The railings, newels, lamp posts, etc., are all of concrete. The bridge was designed and built by Mr. Michael De Palo, Engineer, of Los Angeles, Cal.

REINFORCED CONCRETE HIGHWAY ARCH OF 146-FT. SPAN, PLAYA DEL REY, CALIFORNIA.

RECENT EXTENSIONS OF THE EMPLOYMENT OF COMPRESSED AIR.

By Frank Richards.*

The extension of the field of employment of compressed air seems to be going on more rapidly than ever. Its modern line of work really began not much more than a generation ago, and for many years the air compressor was merely the necessary co-worker with the rock drill, so that the builders of the one quite naturally became the builders of the other, and so continue to this day.

Now, however, the applications of compressed air have become so numerous that rock drills do not consume one-quarter of the air that is compressed. Pneumatic tools, hammers, riveters, calkers, borers and the rest, which are closely related to the rock drill, are found in quite as large numbers; and there are, moreover, other extensive uses of compressed air which are as different as possible.

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It may be mentioned incidentally that at the present writing there are employed on the tunnel and railroad work in and around New York City 80 air compressors, most of them running night and day. These are mostly large Corliss compressors of high efficiency, all of them either Ingersoll or Rand machines, and their combined free air capacity is 186,000 cu. ft. per minute, which volume would equal that of a cube with a side of 57 ft.

THE RETURN-AIR PUMP.

The use of compressed air for raising water would seem to be a very natural and common-sense application of it. Different devices have been employed and are continually being exploited for the purpose. Some of them, such as the air lift and certain of the forms of the direct displacement pump, are more than holding their own, either by reason of convenience of application or by complying with some conditions otherwise prohibitive. But against both of them there is the objection, fatal to their general or universal employment, that they are not cheap to operate.

The objection to the direct displacement compressed air pump, that it does not make use of the potential energy of expansion of the air, but that after displacing the water, volume for volume, the air is allowed to escape at the full pressure, has seemed until now to be inherent and ineradicable. Here we have a chamber which was filled with water to be raised to a certain height; air at a sufficient pressure has been admitted to the top of the chamber, the water has been forced out of it and up the pipe to the point of delivery, and the chamber is now full of air at the full working pressure. Now what can you do with that charge of air? The question has seemed to be final, and every time we have let the air go.

The return-air pumping system is extremely simple, but the invention must be considered a great one, and nothing short of revolutionary in its bearing upon the general problem of water lifting by compressed air. While the familiar direct displacement pump takes in for each charge all the compressed air it can hold, not only for the actual dead lift of the water but also to fill all clearance spaces, and then throws it all away and gives back nothing, the return-air system does the same work in the same way, but uses only the power which is necessary to do the work, *and gives back all the change.* That is, the entire expansive force of the released air goes back to the intake side of the compressor and repays to that extent the cost of the compression. This return shove of the air in its expansion transforms the air displacement pump from a wasteful to an economical device and thus opens up great possibilities of additional profitable employment for compressed air.

The return-air pump is not a "cheap and handy" device for miscellaneous or temporary use, but is intended for the larger and more permanent installations. The system is in each case put in as a whole, compressor and all, and it does only its own specific job of raising water, as for town or village water-works, for the water supply of large industrial works or public institutions. For such employment it adapts itself to the widest ranges of pressures, capacities and conditions. Having no working parts to wear or get out of order, it handles either clear water or water loaded with mud, marl, sand or sewage. It can do any job of pumping any liquid which any other pump can do, and it will do it reliably, constantly and cheaply.

THE ELECTRIC-AIR ROCK DRILL.

In the compressed air line there is another recent notable invention related to the return-air pump, while its field of employment is as different as possible. This is the electric air rock drill, which is so new that many even of those directly in the line of its employment have not yet heard of it. It is by no means a simple invention, at least in the working out of it. It belongs to what may be called the daring inventions, those the general principle of which is

not so unlikely to be thought of, but which require nerve and perseverance, besides high inventive skill, to follow out and develop to complete success.

The electric-air drill, like the return-air pump, has its own special air compressor, which, however, is more completely and exclusively a part of the apparatus than is the compressor which serves the return-air pump system. By this invention the rock drill is entirely cut away from the standard air compressor, and, so far as it is concerned, the old compressor need no longer exist. Nevertheless the drill is as much an air operated drill as ever it was, so completely so, in fact, that it cannot be operated by steam, which has always heretofore been an acceptable and widely employed alternative vehicle of power for rock drills.

Under the old system, the rock drill being fixed in position for its work upon the rock, the piston, carrying the drill steel, was reciprocated by the alternate admission and discharge of the air into and out of each end of the drill cylinder. The valve, which controlled the transfer of the air to and from each end successively, was thus an important and inseparable part of the drill, and the devices by which the valve was operated have for years challenged the skill of the ablest inventors.

The new invention is so revolutionary in character that, to begin with, the drill has no valve or valve motion. A little compressor—I call it here a compressor by habit and to avoid a too sudden shock in description—of capacity exactly adapted to that of the one drill which it is to operate, is located near the drill, and two separate pieces of hose each connect one end of the compressor cylinder to one end of the drill cylinder. The hose and the cylinders are normally filled with air at a pressure of say three atmospheres, 30 lbs. gage, or a little above that, and there are no valves or obstructions to prevent the free flow of the air through the hose or into or out of either cylinder. The compressor piston is driven by a small electric motor mounted upon the same truck with the compressor and geared down to the desired speed. It will be seen that, as the compressor piston reciprocates, the pressure rises in front of it and becomes lower behind it, causing corresponding differences of pressure in the two ends of the drill cylinder; the drill piston is reciprocated by these alternations of pressure. There is no additional air taken in, except for leakage, or discharged, and the compressor may more properly, therefore, be called a pulsator.

The entire arrangement, while at first sight apparently a complication, is in fact a great simplification of the apparatus employed in rock drilling. The drill itself is stripped of the parts which have always been the most costly in construction and also for maintenance and frequent renewal. All the valves, valve chests and valve operating devices are entirely discarded and also the buffers and cushioning devices for the heads. The "compressor" also has neither inlet nor discharge valves, and it has no use for a water jacket, as the heating of the air by compression on the one stroke is immediately compensated by the fall of temperature which accompanies the fall of pressure on the return stroke. The drill piston works, reversely, stroke for stroke with the pulsator piston, and is checked at each end of its stroke by the elasticity of the air, so that the force is not lost but is transmitted to help the next stroke. We have here again in another form the important power economy feature of the rteurn-air pump, as the device also retains and applies all the elasticity of the air instead of releasing it unused as always used to be done.

As to the efficiency of the drill in actual work, there is no need of theorizing, as practice has determined that it shows a very great saving in power. The drill has been kept very quiet, so far as the public is concerned, but at the same time it has been thoroughly tried in considerable numbers, in different kinds of rock, under the most exacting conditions of service and for a period covering several years. The evidence is that the drill is not only all right in every particular but is superior in accomplishment and in endurance. The complete success of it on thorough and protracted trial has entirely warranted arrangements for the manufacture of the drill upon an extensive scale.

THE HIGH PRESSURE TRANSMISSION OF ARTIFICIAL GAS.

A third development of compression practice, which, however, involves no new invention and really has nothing to do with compressed air, comes naturally to be spoken of here because it provides new and extensive employment for the air compressor. The air compressor, in this case, becomes a gas compressor, and is employed for the high pressure transmission of artificial illuminating gas.

The artificial gas business may be said to be, nearly always and everywhere, a growing business. Every community increases, the manufacturing and residential areas are always extending, and at the same time new uses of gas are constantly developing; consequently, a gas plant which at any given time is only sufficient

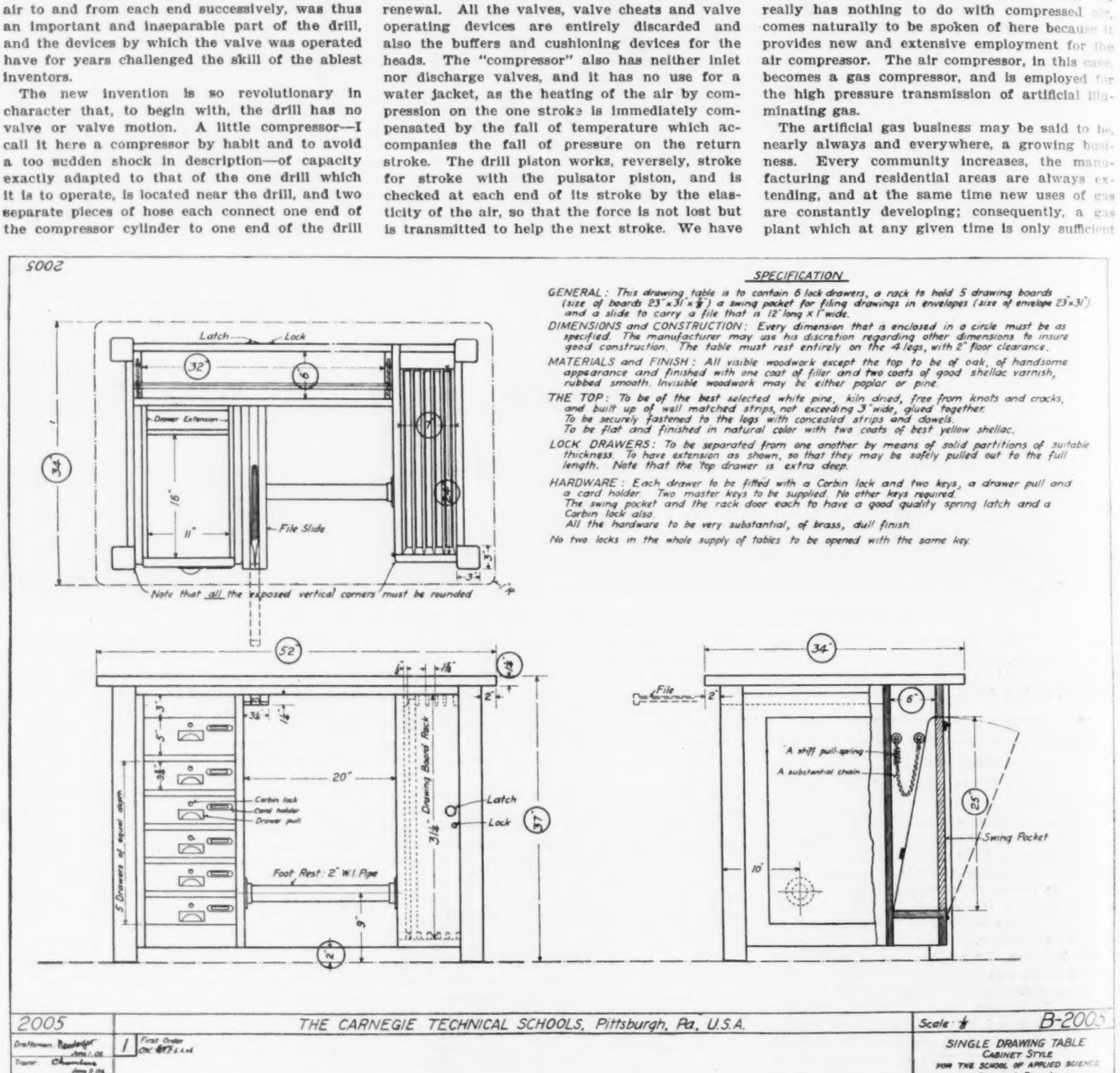
5002
SPECIFICATION
GENERAL: This drawing table is to contain 6 lock drawers, a rack to hold 5 drawing boards (size of boards 23"x31"x ¼") a swing pocket for filing drawings in envelopes (size of envelope 25"x31") and a slide to carry a file that is 12" long x 1" wide.
DIMENSIONS and CONSTRUCTION: Every dimension that is enclosed in a circle must be as specified. The manufacturer may use his discretion regarding other dimensions to insure good construction. The table must rest entirely on the 4 legs, with 2" floor clearance.
MATERIALS and FINISH: All visible woodwork except the top to be of oak, of handsome appearance and finished with one coat of filler and two coats of good shellac varnish, rubbed smooth. Invisible woodwork may be either poplar or pine.
THE TOP: To be of the best selected white pine, kiln dried, free from knots and cracks, and built up of well matched strips, not exceeding 3" wide, glued together. To be securely fastened to the legs with concealed strips and dowels. To be flat and finished in natural color with two coats of best yellow shellac.
LOCK DRAWERS: To be separated from one another by means of solid partitions of suitable thickness. To have extension as shown, so that they may be safely pulled out to the full length. Note that the top drawer is extra deep.
HARDWARE: Each drawer to be fitted with a Corbin lock and two keys, a drawer pull and a card holder. Two master keys to be supplied. No other keys required. The swing pocket and the rack door each to have a good quality spring latch and a Corbin lock also. All the hardware to be very substantial, of brass, dull finish.
No two locks in the whole supply of tables to be opened with the same key.
Latch
Lock
Drawer Extension
File Slide
Note that all the exposed vertical corners must be rounded
5 Drawers of equal depth
Corbin lock
Card holder
Drawer pull
Drawing Board Rack
Foot Rest: 2" W.I. Pipe
File
A stiff pull-spring
A substantial chain
Swing Pocket
2005
THE CARNEGIE TECHNICAL SCHOOLS, Pittsburgh, Pa., U.S.A.
Scale: ½
B-2005
SINGLE DRAWING TABLE
CABINET STYLE
FOR THE SCHOOL OF APPLIED SCIENCE
General Drawing

FIG. 44. A SAMPLE WORKING DRAWING OF THE "ILLUSTRATED SPECIFICATION TYPE."

for its existing business soon becomes insufficient, and then has to be pieced out in some way. The usual and traditional pressure at which gas has been transmitted has always been absurdly low, and the first suggestion in amelioration of inadequate supply is to increase this pressure and so force more gas through the pipes.

Many gas companies have, therefore, changed to a high pressure transmission, so that where formerly the pressure was measured by a few inches of water it now registers many pounds on a pressure gage. First fan blowers have been put in, then pressure blowers and finally gas compressors, with pressures this side of the Mississippi up to 50 lbs. and in California up to 100 lbs. It is not meant that there has been anywhere any tearing out or giving up of existing plants. The new high pressure system has entailed practically no sacrifices such as are generally involved in changes of practice. Old companies with the old light pressures continue their old plants intact, but assist the transmission to distant points of their service by small pipes with gas at high pressure, which is finally released into the low pressure system. For extensions into new territory the high pressure system is frequently being installed in its entirety, the gas going direct to the consumers under the high pressure, with individual pressure reducers. The small sizes of the pipes required, for instance 2-in. instead of 12-in., and the ease with which they may be laid has led to the use of gas by isolated consumers—farmers and others—who under the low pressure system would have been inaccessible. The high pressure gas distribution, whenever it is installed, always stays and encourages the more extensive use of the system. It shows indisputably that the gas holder, an unsightly accompaniment of modern civilization, is no longer a necessity, and suggests inquiry as to how long it will be tolerated.

These three specific developments: the return-air pumping system, the electric-air drill, and the high pressure transmission of artificial gas, involving extensive additional employment of compressed air, or at least of the air compressor, are well worth watching, for each promises to be largely employed and with good success. It is a notable circumstance that three such remarkable advances in practice should have come so near together, and should have been so nearly related to a single line of industry. It will be worth while to keep informed about them and to watch their progress.

A UNIVERSAL DICTIONARY OF MECHANICAL DRAWING.*

By George H. Follows.†

Part XII. Example Drawings.

156. Figs. 44 and 45 are reproductions of actual working drawings belonging to the type that this dictionary is intended to govern—the "illustrated specification." They are introduced here merely as examples of the writing of the language, and not because they deserve any special study or teach any particularly valuable lesson in themselves. Their purpose is to illustrate in a general way the dictionary features covered in the preceding chapters.

157. The only way that any man can hope to become a draftsman of the highest type is to make drawings; an examination of the drawings made by somebody else can do him very little good. It is a comparatively easy matter for any draftsman or drafting room to adopt such drawing features as are purely mechanical—the alphabet of lines, styles of lettering, figures and dimensions, projection, sectioning, the finish mark and the record strip—but it is only by the persistent exercise of care, common-sense and good judgment in the actual making of drawings that the individual can develop into the high-class draftsman.

158. In Fig. 45 certain pieces are "item numbered" and the drawing carries a list of the items in the form of a "bill of material," as it is generally called. Some such list is often used in the modern drafting room, the form and contents depending, of course, upon the nature of the work specified, and the kind of information required by the shop. The only reason for directing any attention here to the bill of material is to advise against the practice of using ditto marks in any such lists on drawings. The bill of material is in effect a collection of independent specifications, and each specification should therefore be independently complete; otherwise it will happen that a change intended to affect only one item will go through as affecting all those ditto marked under it.

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†The Park View, East Liberty, Pittsburg, Pa.

A WIRE-ROPE TRAMWAY for transporting iron ore has been built near Fort Montgomery, N. Y., on the Hudson River, for the Hudson Iron Co., by the A. Leschen & Sons Rope Co., of St. Louis. The tramway is 6,300 ft. long and delivers the ore at a point 390 ft. below the starting point. Its capacity is 23 tons per hour. The ore buckets are permanently attached to the rope and are loaded by a traveling automatic loader or hopper.

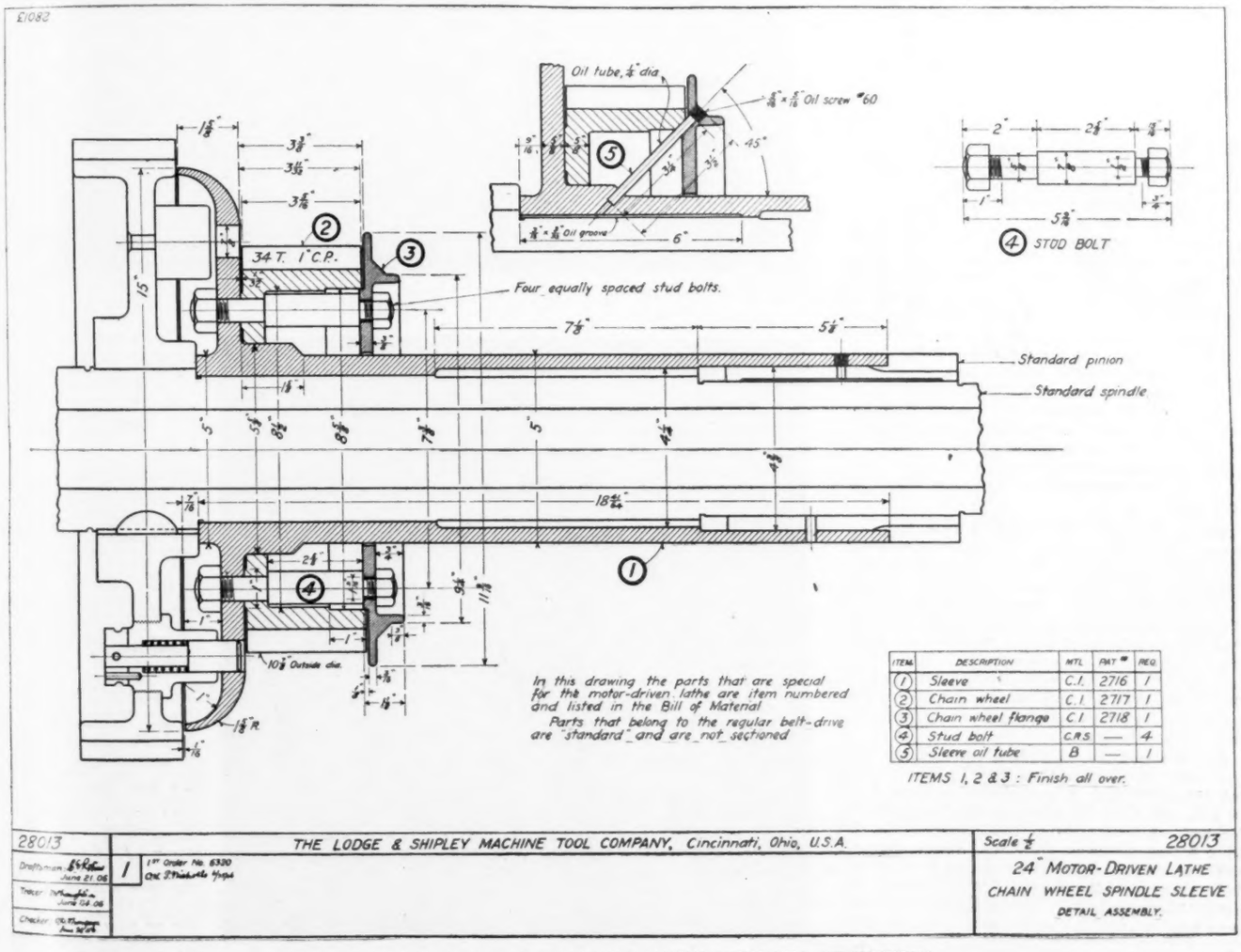

E1082
Oil tube, ¼" dia.
⅜" × ⅛" Oil screw #60
45°
⅜" × ⅜" Oil groove
6"
34 T. 1" C.P.
Four equally spaced stud bolts.
Standard pinion
Standard spindle
10⅜" Outside dia.
STOD BOLT
In this drawing the parts that are special for the motor-driven lathe are item numbered and listed in the Bill of Material.
Parts that belong to the regular belt-drive are "standard" and are not sectioned
ITEMS 1, 2 & 3 : Finish all over.
ITEM | DESCRIPTION | MTL | PAT. # | REQ.
1 | Sleeve | C.I. | 2716 | 1
2 | Chain wheel | C.I | 2717 | 1
3 | Chain wheel flange | C.I | 2718 | 1
4 | Stud bolt | C.R.S. | — | 4
5 | Sleeve oil tube | B | — | 1
28013
THE LODGE & SHIPLEY MACHINE TOOL COMPANY, Cincinnati, Ohio, U.S.A.
Scale ½
28013
1st Order No. 6320
24" MOTOR-DRIVEN LATHE
CHAIN WHEEL SPINDLE SLEEVE
DETAIL ASSEMBLY.

FIG. 45. ANOTHER SAMPLE WORKING DRAWING WITH BILL OF MATERIAL.

VARIATIONS IN STRENGTH OF ROLLED STEEL PLATES DUE TO SEGREGATION OF CARBON.

A tacit assumption underlying the design of all structures, at least ever since the use of testing-machines became general, is that the resistance of the material when in use is the same as that shown in the specimen test. The vast subject of Mechanics of Stresses deals primarily with the problem of establishing measurable relations between the action (upon the material) of the attacking forces in the actual structure and the simple pull in the testing-machine. And the whole study of material testing is occupied with discovering and eliminating the variable influences which disturb these theoretical relations. Evidently, therefore, it is essential that the piece of material which we place in the testing-machine be identical in nature with the material it is taken to represent, and also that the material be homogeneous, that is to say equally strong in all its parts. Where these conditions are not fulfilled with reasonable accuracy, as in the testing of timber, our knowledge of the strength of the material remains restricted and uncertain, so that high factors of safety must be used.

We are in the habit of thinking that plate steel, as rolled for structural, boiler and similar work, is almost perfect, in this sense, in its homogeneity and definiteness. It has not the grain of wood, nor the variations of density and structure which make the strength of wood so variable. We think of it as a sheet of uniformly structureless substance, chemically and mechanically the same in all parts, except, perhaps, for a slight difference in strength transversely and longitudinally due to rolling. The properties that are important for structural purposes (tensile strength, ductility, hardening ability as represented by carbon content, etc.) are determined from test-pieces taken from the most convenient place, the edges or ends of the plate, and are confidently applied to the whole section of the plate.

This assumption of uniformity of rolled steel plate is seriously in error, as was shown most strikingly in a paper* read recently before the American Society for Testing Materials by Mr. Charles L. Huston. It has been known previously that the tendency of the metalloids in the ingot to separate from the iron and collect in certain locations, a tendency generally called "segregation," affects plate ingots just as well as rail ingots, though the lower proportion of carbon in the former makes the results much less pronounced and therefore less serious. Moreover, experiments have been published showing somewhat greater strength in that part of a plate which came from the top of the ingot, and lower strength of the metal at the bottom. But the statement of conditions which Mr. Huston gives is much clearer and more complete than any yet given, and engages the close attention and study of every one interested in the use of plates of mild steel.

The photographs reproduced in Figs. 1, 2 and 3 were taken from ingots of various sizes after they had been planed down to the center line. They show the character of the interior of the ingot and throw some light on the results of the mechanical tests explained below. The ingots were of different shapes and weights, purposely so selected in order to show the difference in the character and extent of the segregation in the different sizes and shapes, and at the same time to show certain general characteristics common to all.

Fig. 1 shows an ingot of about the smallest size used for direct rolling, 9 × 12 ins., weighing about 900 lbs. Fig. 2 shows an ingot 12 × 26 ins., weighing 2,850 lbs., a size largely used for both sheared and universal plates. Fig. 3, 38 × 8 ins., weighing 2,950 lbs., is an unusual size, but one which the Lukens Iron & Steel Co. finds very advantageous for certain classes of work. These three ingots were poured from the same melt of steel and at the same time, by bottom pouring. One ingot of each size was planed for photographing, and its duplicate rolled into a plate for tensile and chemical test. Mr. Huston said, in explanation of the photographs:

> The steel when poured is very fluid, and is in constant motion and circulation in the mold, this movement causing a continued generation of gases which pass off through the molten steel and escape, at the same time there is forming against the mold a steadily increasing coating or wall of solidified steel. As the temperature falls, however, the molten steel becomes steadily less fluid until a stage is reached where the bubbles fail to pass off through it because of its increasing thickness of consistency, and are caught just at the one point as shown in the photographs. This thickening of consistency also operates to prevent the further circulation of the steel, and consequently the further generation of gases; that portion lying inside of this zone of holes first becoming of pasty nature and then solidifying practically all in one mass. Although these different photographs are from a number of different sizes and weights of ingots, yet they all show the same general characteristics as to the formation of the little holes or gas bubbles, all being some distance in from the outer surface of the metal.
>
> This result is aimed at as the best average condition for producing the best results we can secure in making plates. Sometimes if care is not exercised the bubbles will form immediately under the surface, taking the shape of honeycomb cells at right angles to the surface of the ingots; these in the after heating and rolling will develop into a very rough or pitted surface which makes the plates unfit for the market. Conditions of temperature of pouring and consistency of the steel, judged by experience, are necessary to avoid these results, and can be very largely controlled by the steel melters.
>
> The question would naturally arise as to these holes causing unsoundness in the plate, but it is quite evident that they all or nearly all close up if they are clean and free from oxides and dirt, the temperature to which the steel is heated for rolling being sufficient to bring about the practical union of the surfaces when they are pressed down into contact. This was strikingly manifested in some of the ingots which were planed down to half thickness and subsequently rolled. They were heated with the hole side down and thus the cinder did not run into the holes and they were left free to close up under the pressure of the rolls, the plates coming out with as clean a surface on that side as the other. If they had been heated with the holes on the top side, the

*Experiments on the Segregation of Steel Ingots in Its Relation to Plate Specifications.

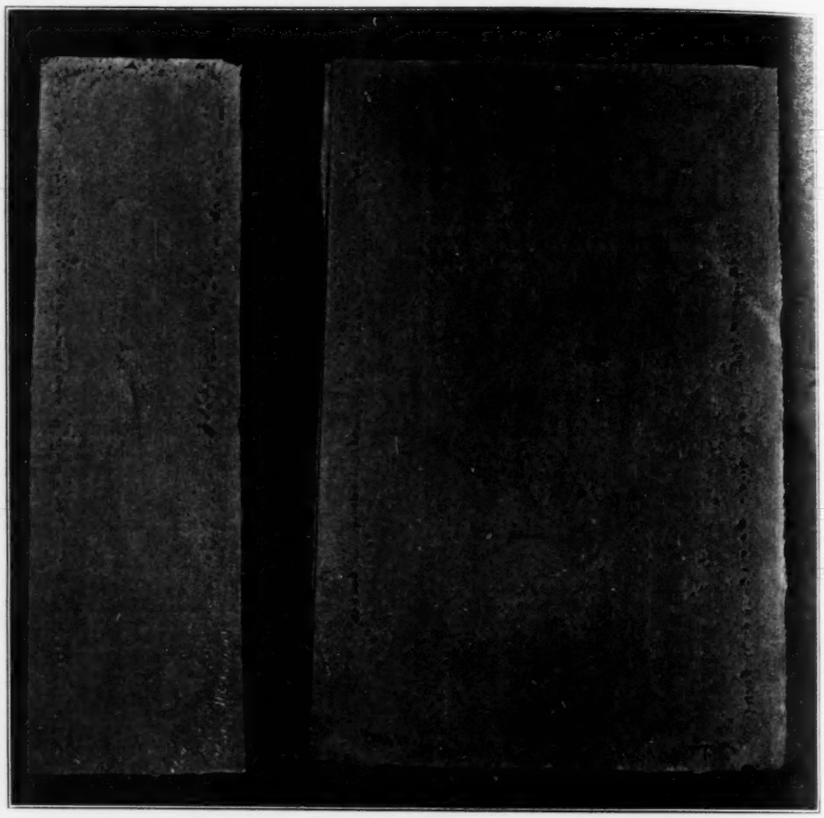


Fig. 1. 9 x 12-In. Ingot, 900 Lbs.

FIG. 2. 12 x 26-In. INGOT, 2,850 LBS.

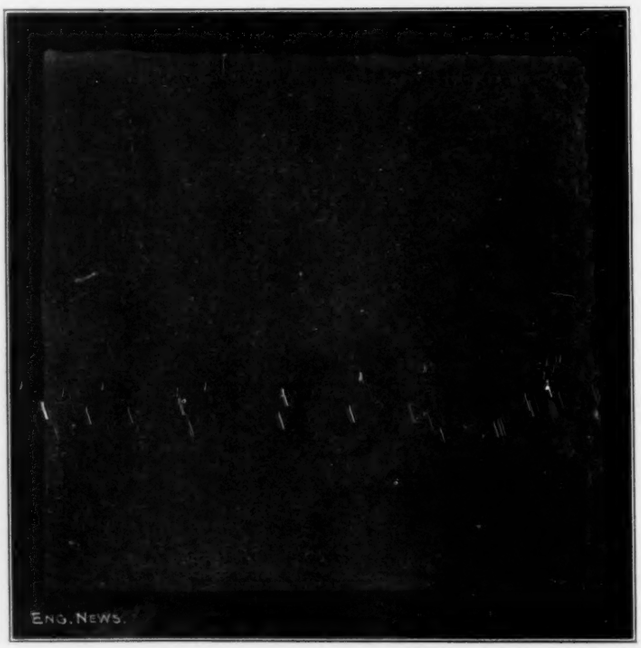


FIG. 3. 38 x 8-In. INGOT, 2,950 LBS.

FIGS. 1-3. THREE TYPICAL PLATE INGOTS CUT DOWN TO CENTRAL PLANE TO SHOW STRUCTURE.

cinder would have run down into them and could not have been eliminated in the rolling.

Steel with higher carbon, such as is used in rails, and steel treated with ferrosilicon and other similar materials, such as is used for steel castings, has a different character from that shown in these photographs, and seems to incline more to run to a pipe in the center, owing to the different behavior of the metal in the mold in process of cooling.

The carbon and other "impurities" in the steel seem to distribute themselves in a manner related to the structure shown by Figs. 1 to 3. In ingots for rails, the constituents other than iron are found in highest percentage in the upper, unsound, part of the ingot. In the low-carbon ingots here discussed, the chemical segregation is not so localized. In Fig. 4 are given the carbon percentages at different points in a $^{5}/_{16}$-in. plate rolled direct from a 16 × 18-in. ingot weighing 2,800 lbs. The ladle test of the heat from which the ingot was poured showed 0.18% carbon, but the diagram shows that the plate varies from 0.13 to 0.27% carbon; an envelope of metal extending around the sides and bottom has lower carbon than average (0.13 to 0.16%), while the interior, except the very top, is almost uniform at 0.20 to 0.23% carbon. The same general conditions may be read from Figs. 5 to 10.

A more precise parallel between the carbon segregation and the ingot structure is demonstrated by Fig. 12, a chart showing carbon determinations at various points along a radial line in a 16 × 18-in. ingot. The chart shows that the highest percentage of carbon occurs just at or inside of the zone of gas holes; the core inside of this zone is almost uniform in carbon, to the very center of the ingot. There is no accumulation of carbon at the center, as found in rail ingots.

The extent of segregation in a much larger ingot of similar low-carbon material is shown in Fig. 11, a diagram of a 15-in. slab rolled from a 15-ton ingot. Drillings were taken on the center line of the slab at the three transverse cuts shown. Although the ladle test gave only 0.23% carbon, the drillings show a carbon percentage varying from 0.15% to 0.63%, both maximum and minimum occurring at the top; the variation at the mid-length section is from 0.17% to 0.30%.

In Figs. 11 and 12 the drillings for analysis were taken on cross-sections of the ingot, so

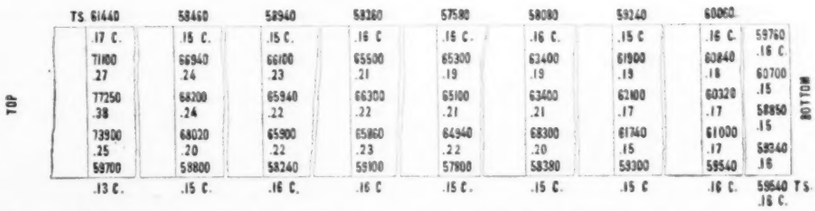


FIG. 10. VARIATION OF TENSILE STRENGTH AND CARBON CONTENTS IN PLATE ROLLED FROM SLABS.

Ingot, 30 × 34 ins.; weight, 17,600 lbs.; ladle test, 0.19% carbon; rolled 3½ ins. thick by 29 ins. wide and cut into eight slabs 67 ins. long. Slabs rolled into ⅝-in. plate. Five longitudinal test-pieces were taken from the top end of each plate, and a ninth set of five from the bottom of the lowest plate, thus giving five tests each at top and bottom and at seven intermediate sections. At each section the test-pieces were spaced equi-distant across the plate.

that they represent the variation on a radial line of the ingot. When the ingot is rolled into a plate, either direct or after preliminary rolling into slabs, every small area of the plate represents the result of compressing a rod of metal passing transversely all through the ingot; it therefore includes a section of core and a section of the skin lying outside of the zone of gas holes. Analyses made from drillings of a plate (when the drill is run through the full thickness of the plate) therefore will not show the maximum differences of carbon content which existed in the ingot. The carbon percentages given in Figs. 4 to 10 were (except in one case, Fig. 9) taken from the plate, and in comparing them with Figs. 11 and 12 this fact must be remembered.

The mechanical properties of the plate vary directly with the carbon percentages. To prove this variation, a series of tests was made whose results are shown in Figs. 4 to 10. The first six of these diagrams refer to plates each rolled direct from a single ingot, while Fig. 10 covers an ingot which was rolled into slabs and these latter separately rolled into plates. Plates of ¼-in., $^{5}/_{16}$-in., ⅜-in., and $^{29}/_{32}$-in. thickness are represented. All the material is of the 60,000-lb. grade used for structural work and boilers.

It is seen at once that all the plates are bordered by a strip of low tensile strength, while the entire middle portion is of high strength with a general increase from bottom toward top. In Fig. 4 the outer strip averages about 56,000 lbs. per sq. in., while the middle has a strength around 64,000 lbs. Fig. 5 similarly shows 55,000 lbs. at the edges and 62,000 in the middle; Fig. 6, 58,000 and 63,000; etc. The extreme differences in each case are much higher, amounting for example to 12,000 lbs. in Fig. 4. This variation in tensile strength has the same distribution as the variation in carbon, above discussed. Detailed comparison of the figures for carbon and tensile strength, in Figs. 4 to 10, establishes a remarkably regular parallelism, the regions of low carbon being the regions of low strength, and those of high carbon the regions of high strength.

To further confirm the conclusion that the variations in strength shown in these tests are due to segregation, it may be noted that the larger or thicker ingots in this series of charts show greater variations of strength than the smaller or flatter ingots. Rapid solidification of an ingot must be assumed to interfere with the progress of segregation, and conversely the slower cooling of a large ingot should result in greater segregation than found in a small ingot. The strengths given in Fig. 10 illustrate the influence of size.

Mr. Huston, in the original paper, states the conditions as follows:

> The experiments seem to show that the portion of the ingot lying inside of this zone of holes (which might be called the core of the ingot) is practically all of one character, with slight excess in tensile strength and hardness at the top as compared with the bottom, caused by the hardening elements floating toward the top. They also show that the larger the ingot and the greater the

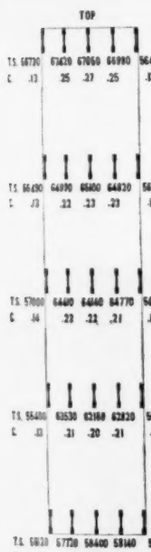


Fig. 4. 16 x 18-In. Ingot, 2,800 Lbs., Ladle Test 0.18% Carbon.

Rolled to $^{5}/_{16}$-in., plate 74 ins. wide by 370 ins. long.

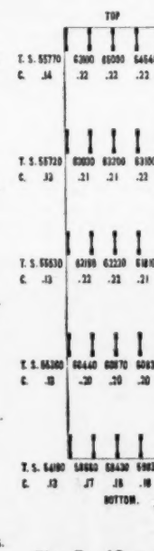


Fig. 5. 12 x 26-In. Ingot, 2,850 Lbs., Ladle Test 0.18% Carbon.

[Duplicate Planed Down to Center, and Shown in Fig. 2.]

Rolled to $^{5}/_{16}$-in., plate 75 ins. wide by 330 ins. long.

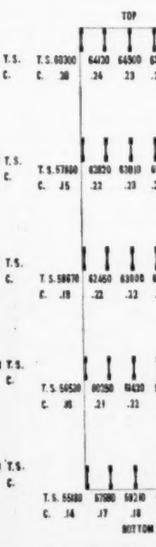


Fig. 6. 38 x 8-In. Ingot, 2,950 Lbs., Ladle Test 0.18% Carbon.

[Duplicate Planed Down to Center, and Shown in Fig. 3.]

Rolled to $^{5}/_{16}$-in., plate 76 ins. wide by 350 ins. long.

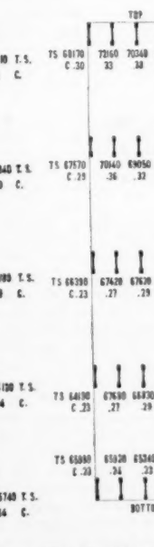


Fig. 7. 22 x 15-In. Ingot, 3,775 Lbs., Ladle Test 0.19% Carbon.

Rolled to ⅝-in. plate 78 ins. wide by 378 ins. long.

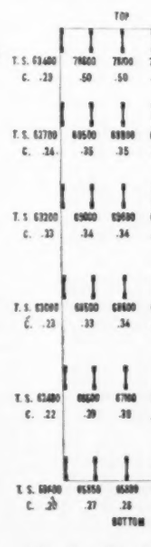


Fig. 8. 48 x 20-In. Ingot, 11,000 Lbs., Ladle Test 0.26% Carbon.

Rolled to $^{29}/_{32}$-in. plate 94 ins. wide by 335 ins. long.

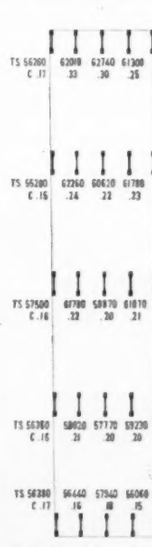


Fig. 9. 26 x 12-In. Ingot, 2,800 Lbs., Ladle Test 0.19% Carbon.

Planed to half thickness and rolled to ¼-in. plate.

Note: The carbon figures on this diagram are from drillings taken from the center plane of the ingot, instead of from the plate.

FIGS. 4-9. DIAGRAMS SHOWING VARIATION OF TENSILE STRENGTH AND CARBON CONTENTS IN PLATES MADE BY DIRECT ROLLING FROM THE INGOT.

Each diagram represents the complete plate rolled from a single ingot; the tensile test specimens and drillings for carbon, taken at the points shown, therefore represent corresponding points of the ingot. The upper end of the diagram represents the top of the ingot in all cases. Note that each test represents an average of the entire thickness of the ingot at that point.

mass of metal, and, consequently the greater the length of time taken in solidification, the greater is the extent and degree of this segregation, so that though a large ingot may be rolled out and cut up into separate slabs as shown in Fig. 10; there is still a very great difference between the outside edges and the center of each slab, and a discard of even a large percentage from the top part of the ingot will not materially lessen this condition.

Now in the practice of rolling and shearing it is generally not practicable to secure test pieces from any portion other than the sides of the plate as rolled, and hence it is obviously necessary to so roll the ingot or slab that the sides of the plate will represent as nearly as possible the outer skin of the ingot; otherwise there would be no uniformity of results and consequently no satisfactory record of tests to report. It will be evident from this that in general mill practice, while we can report practically uniform tests from plates of the same size rolled from the same melt of steel, yet there is

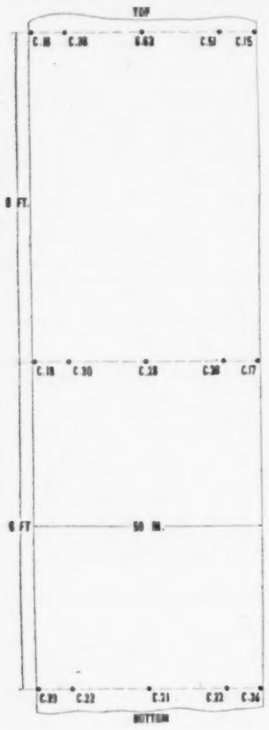


Fig. 11. Diagram Showing Segregation of Carbon in 15-Ton Mild-Steel Ingot.

Ingot, 30 × 52 ins.; weight, 30,600 lbs.; ladle test, 0.23% carbon; rolled 15 ins. thick and 50 ins. wide. Tests taken from drillings on line through center of each cut.

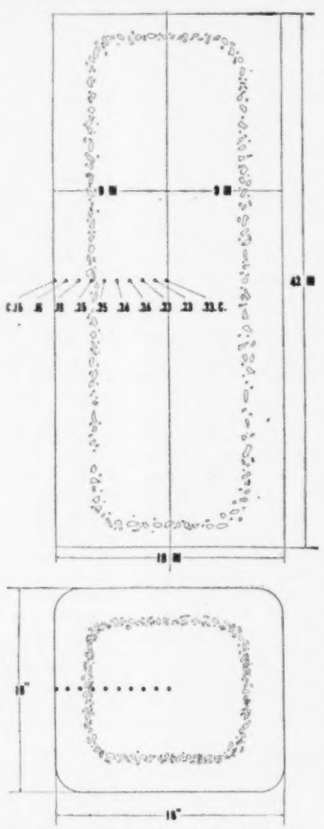


Fig. 12. Diagram Showing Radial Distribution of Carbon in Ingot, with Maximum at Line of Blow-Holes.

Ingot, 16 × 18 ins.; cut longitudinally through center and drilled for carbon determinations at 10 points equally spaced as shown.

metal in all these plates higher than the records show, and this, in the case of steel specified to be of high tensile strength, runs up very close to the danger line, often times seeming to us, as manufacturers, to be over the danger line. Take for instance plates 1 in. or thicker, for marine boilers and specified to be 60,000 lbs. (or more) minimum tensile strength; this requires a hard steel at the best, and where test pieces have to be taken from opposite diagonal corners of the plate as is now required by the United States Board of Supervising Inspectors of Steam Vessels, necessitates bringing up the softest part of the steel to the minimum requirement, and the hard core or center which necessarily remains in the plate even after discarding a large proportion (say the top third) of a large ingot, goes into the boiler and is liable later on to cause cracking and trouble, if not danger.

Metal which if tested in moderate thickness, say, ⅝-in., would show 75,000 lbs. tensile strength, would be considered too hard to use, yet the same steel is required for making plates of 1½ ins. thickness or thereabouts, in order to produce 60,000 to 65,000 lbs. tensile strength, and considered quite acceptable, while as a matter of fact it is much safer in the ⅝-in. thickness than in the 1½-in. thickness because of the refining effect of the rolling action.

I believe statistics will show that troubles attributable to the steel in boilers and structural work have arisen from steel being too hard, and seldom from being too soft; hardness being needed mainly to withstand abrasion or wear and in itself being of less importance for the strength of structures where a liberal factor of safety is provided for the working stress.

The argument in favor of lower (or at least conservative) tensile strength requirements for structural and boiler steel, contained in the above quotations, will be clear without further explanation. We may note that at the meeting at which this paper was read, a motion was made to reaffirm the 60,000-lb. standard of the American Society for Testing Materials, but the motion was declared out of order. It is probable that fuller discussion of the matter will be entered into at the next annual meeting of the society.

PIPING IN STEEL INGOTS.*

By N. Lilienberg.†

During the past few years the requirements for steel have been raised so high that soundness is more important than ever before. The old practice was to make steel ingots of sufficiently large sections to permit a considerable reduction of area in rolling and hammering to a given size, relying on the fact that by such rolling and hammering all cavaties will be squeezed together and practically eliminated. The finished sizes, if found by inspection of the surface to be faultless, were therefore pronounced to be sound. When such steel is "worked up," however, the manufacturer is surprised and disappointed to find that it splits, or that streaks and seams make the product unmarketable. Large sections, such as rails, beams or heavy forgings, may, within certain limits, be sufficiently strong, even if the sides of the cavities are only squeezed, and not welded together but it is well known that in the interior of heavy articles under certain conditions, forging may develop small streaks into large cavities. Small sections, steel for ordnance and tubes, and numberless articles in the tool-trade, always show up the defects. It may be doubted whether cavities in steel ingots can ever be completely welded, although the old theory is, that the silver-clear blow holes, without the blue oxide, can be welded by sufficient working. They are, however, not empty, but are filled with carbonic oxide. It is admitted that the "blue" cavities, resulting from air mechanically drawn down into the mold during the casting, can never be welded, because the oxide does not melt, and there would be no escape for it if it did. The only way in which steel can be made satisfactory for the above-named particular purposes is by having it "dead molten," and one then encounters the trouble of piping.

As is well known, a pipe is the result of the contraction of the liquor interior after the surface of the ingot has become solid by contact with the mold. With this contraction is partly taken up by blow-holes, there is, of course, less sinking of the metal at the top, and the soundest steel, therefore, has the worst pipe. Some manufacturers having found that, for certain purposes, piping is a worse evil than blow-holes, are, therefore, purposely casting honey-combed ingots. Several manufacturers rely on casting steel at such a temperature that the blow-holes arrange themselves in a zone midway between the center and the surface, thus making the defects invisible after rolling or hammering; but, aside from the impossibility of always arranging the gas-bubbles in this way, the defects will afterwards appear in working, as above mentioned. The pipe is always coated with blue oxide from contact with the air, this oxide being formed instantaneously; and therefore the common practice of filling-up the pipe with liquid steel during casting and solidification only forms a stopper which is not welded to the ingot.

A great many processes have been invented to obviate piping, but those of importance may be arranged in two classes: keeping the steel liquid, and compression of the steel.

KEEPING THE STEEL LIQUID AS FAR OUT TOWARDS THE MOLD AS POSSIBLE, IN ORDER TO GET AN EVEN SINKING OF THE TOP SURFACE.

All methods working on this principle suffer from the evil, that, the period for solidification being prolonged, the separation of the impurer, and therefore lower, steel has more time to take place, and the segregation will be more pronounced. Under this heading the following five methods may be mentioned:

Addition of Aluminum, either in the ladle or in the molds.—The aluminum increases the heat by combining with part of the dissolved oxygen, and, at the same time, lowers the melting-point of the steel (which, of course, works in the same direction). It is well known, however, to-day, that aluminum does not realize the expectations formerly entertained concerning its value. It makes somewhat sounder steel, but it does not prevent piping; and it has been found, in many instances, to have the tendency to throw a bridge of solid, sound steel over the top of the ingot, thus hiding a large unseen cavity in the interior.

Addition of Thermite.—This mixture of aluminum and iron oxide gives a greater heat than aluminum alone, on account of the extra supply of oxygen present; and its use makes the steel in the mold fairly sound. Insufficient, however, as the higher temperature cannot prevent the steel from solidifying first in the outer layers, a pipe will nevertheless form, although it will be somewhat smaller.

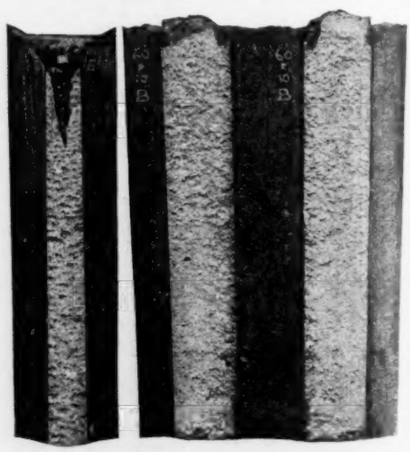
Use of Clay-Lined Funnels.—These funnels, placed on the top of the molds, shorten the pipe, because the steel does not chill as rapidly against the less-conductive clay as against the bare mold. The upper part has then to be carefully cut away, so as to leave no part of the pipe. The exact distance from the top, at which the ingot should be cut, is somewhat difficult to determine, both in this case as well as in the common practice of cutting off the upper part of the ingot and leaving only the lower part for use. In both cases the production is burdened by the considerable cost of fuel, labor and waste involved in remelting the upper or piped portions of the ingots, or of selling these portions at the scrap price, which is below cost.

Casting by Overflow from One Mold to Another.—In this method the molds are arranged in a row close to one another; and while tolerably sound ingots are obtained, there is the disadvantage that much scrap is formed by the steel running through the conduits. It is also obvious that the steel coming to the last mold is much cooler than that in the first.

Use of Electricity.—This method has sometimes been used to heat the upper part of the mold, and thereby prevent the chilling of the steel in contact with the sides before the center gets solid. It is obvious, however, that in order to be effective, the heat would have to be so great that the mold would be destroyed by the steel which would readily attack the walls. Moreover, the method is considerably more costly than that of cutting off the piped part.

COMPRESSION OF THE STEEL IN THE MOLDS.

Much has been said and written about liquid-compressed steel, and the general opinion seems to be that, aside from the obliteration of the pipe, little or nothing is gained by compressing liquid steel, which is absolutely sound and "dead" molten. Since liquids in general are inelastic, and therefore incompressible, the possible degree of compression for liquid steel depends on the included gases. If the press is arranged so that these gases, which are elastic, have no avenue of escape, the effect of the compression will only be to leave cavities of smaller size. I need hardly say that the compression of liquid steel in the mold has quite a different effect from that of forging the ingot afterwards, as in the latter case, the object is to change the structure of the



Ingot Cast and Cooled in Ordinary Solid Mold, Showing Piping at Upper End.

Ingot Cast and Compressed in Sectional Mold During Cooling, Showing Absence of Piping.

Fig. 1. Steel Ingots Split Longitudinally.

*A paper read before the American Institute of Mining Engineers.

†Metallurgical Engineer, 1007 Betz Building, Philadelphia, Pa.

steel at the same time with its shape. Among the numerous devices for compressing steel in molds the following three methods may be mentioned:

Pressure from the Top.—While there is no difficulty in this method, if the whole charge goes into one mold, the machinery will be considerably complicated if several ingots of smaller sizes have to be cast. These ingots will have to stand on trucks and move in procession under the press; or several presses will have to be arranged with additional complications. It is almost impossible to time the casting and the pressing in harmony, for if

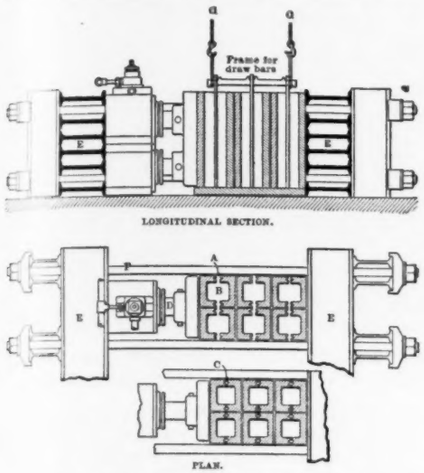


Fig. 2. Illingworth Casting Machine.

the latter is done too early, the cavities will continue to form in the interior of the steel, if too late, the pipe is already formed and oxidized, and therefore will only be squeezed together, but not eliminated, while any compression from the end of an ingot is attended with the danger of tearing the interior loose from the surface. This process is in use in some places in England and Germany.

Compression from the Bottom.—This idea originated in practice at St. Etienne, France; and the process is in use at several French works. It naturally suffers from all the disadvantages of the top-compression, and, in addition, the hydraulic machinery is contained in a deep pit, which makes it difficult to be cared for, and also exposes it to slag, dirt, and accidental spirts or leaks of liquid steel.

Compression from the Sides.—In this method the top is left open, permitting the gases to escape, and the pressure is applied directly in proportion to the formation of the pipe, so as to keep the ingot always full to the top. It is obvious that the pressure can be better timed in this way than in the preceding cases.

Some years ago an apparatus of this kind was built in Pittsburg, having four slowly-moving rollers in the same plane. The ingot, with liquid interior, was taken from the mold and placed between the rollers; and as it slowly moved downward the compression kept the liquid steel toward the top, and prevented the formation of pipe. This is undoubtedly the right principle; but it encounters the insurmountable practical difficulty of transferring the semi-liquid ingots from the mold to the rollers, where they are also liable to be warped and twisted. Moreover, if liquid steel be shaken, it is liable to become honey-combed by the escape of part of the gases dissolved in it.

Side-compression in a stationary mold, having none of the objections above mentioned, is now successfully carried out, even with the largest-sized ingots. This has been mainly accomplished by Mr. John Illingworth, who, for a long period, has devoted his large experience to the practical solution of the problem, and has obtained many patents in this field.

Mr. Illingworth began by casting a continuous ingot through a prolonged vertical mold, the lower half of which was cooled by circulating water. The ingot dropped down through the bottomless mold and was broken off by a hydraulic clutch while still red hot. This method, which worked very well for small ingots, presented difficulties for the larger sizes. The second group of Mr. Illingworth's inventions comprises casting machines, built on the principle of hydraulic rams, which squeeze the two halves of the mold slowly together after they have been sufficiently opened to enter a plate between the ingot and the mold. This plate, having the section of a segment of a circle, displaces a corresponding volume of the semi-liquid interior. The two halves of the mold are drawn apart as soon as a thin skin of solid steel has formed, the movement of the molds, which are placed close together, being made by draw-bars connected with the head of the hydraulic rams. This apparatus has given very satisfactory results for small ingots cast from crucibles, but it is not well adapted for casting from a bottom-tapped ladle into large molds. A special apparatus on the same principle was built for this purpose, but the experiments were not continued sufficiently long to secure successful results.

The problem of compressing large-sized ingots, cast from a ladle, is, however, now completely solved. Mr. Illingworth, together with Mr. S. Robinson, has built such casting machines at the steel works of Jessop & Sons, Sheffield, England, which uniformly turn out ingots of the largest size, absolutely solid from top to bottom.

Fig. 1, showing an ordinary cast ingot with pipe, and others, which have been compressed solid from end to end, is both interesting and convincing.

There are two kinds of casting machines, one for large and the other for small ingots. Fig. 2 illustrates the construction and working of these machines, which are covered by U. S. Patent No. 810,654, issued Jan. 23, 1903. The principle is to cast the steel in molds which are divided in halves and held together, during the casting, by hydraulic pressure. In the planed side edges of the molds are grooves which admit bars of a cross-section shown at A, Fig. 2. After the metal has been poured into the mold, sufficient time is allowed for a crust to form while the interior is still liquid. The bars are then withdrawn by chains, G, suspended from an overhead hoist, which leaves an empty space between the two halves of the mold, as shown at B. Hydraulic pressure is then applied from the ram, D, and the outer half of the mold is moved forward slowly, so that the liquid interior is always kept full to the top until the mold is closed, as shown at C. The volumes of the bars correspond as near as possible to the volumes of the cavities which would otherwise be formed.

The large machine is for large ingots cast on trucks, which are transported out of the foundry immediately after casting, each ingot to be compressed separately. This action can be so modified that three 2-ton molds can be compressed at one time.

The small machine is designed to compress ingots of smaller sizes that are cast in groups on the ground. In this case the casting must be made simultaneously in all the molds in order to have the same initial temperature. This effect can be produced either by bottom-casting or by pouring the steel from the ladle through an underhanging trough provided with a hole for each mold. With bottom-cast ingots the gates break off during the movement of compression. These illustrations have been prepared more for demonstration than for working drawings, and for clearness, several details of construction have been omitted. These details have to be modified to suit each particular case.

The hydraulic cylinders on the one side of the press and the back of the molds on the other are supported by six I-beams (E, E, in Fig. 2) laid horizontally on pieces formed to fit them, and held together by vertical beams and screw-bolts.

In regard to the details of working the Illingworth press, 3 or 4 men can cast and compress 6 ingots, 13 ins. square and 40 ins. long, in an hour's time. The edges of the molds have to be planed occasionally, but a mold can be used for about 125 heats before this repair is needed.

It is impossible to give general statements of the cost of operating this press, since the economy would have to be calculated for each particular case.

By careful investigation it has been shown that:

(1) During compression the surface of the ingot is neither crushed nor folded, but is merged in the mass, the same as in the roughing-mill, although the circumstances attending compression are not so favorable as those of rolling.

(2) No groove is formed between the joints of the mold. If, for special steels, there should be some tendency to this, it is easy to make the edges of the bars slightly convex, thus leaving concave grooves in the ingots, which, by compression, straighten out to a plane.

A NEW FORM OF INSULATOR PIN AND FASTENING.

In describing the transmission-line construction of the Long Island R. R. on its electrically-operated New York terminal lines, in our issue of June 14, 1906 (pp. 643-647), attention was called to a new type of insulator pin which is used throughout that system. We omitted to state that the pin is the invention of Mr. W. N. Smith, of Westinghouse, Church, Kerr & Co., who has applied for a patent on the device. The design has been further improved since it was first worked out for the Long Island transmission system, and arrangements are now being made for manufacturing it and placing it on the market under the name of "Smith-Grip" insulator pin.

The descriptive article above cited contained a drawing of the standard pole-top of the Long Island system, carrying eight three-phase lines and eight direct-current feeders, requiring a total of 30 insulators. The Smith-Grip pin is used for all of these, but the scale of the drawing was too small to exhibit clearly the form of pin and fastening. The adjoined photograph of a Smith-Grip pin mounted on a cross-arm and carrying an insulator is therefore shown.

The pin is a casting in the shape of a small stand with spread base, the upper part of the stand being a vertical screw-threaded pin on which the insulator is cemented. The base seats on the cross-arm or other support on which the pin is to be mounted. The pin is held in place by a U-bolt carrying two nuts under a follower-plate below the cross-arm; the yoke of the U-bolt passes through a hole cored in the web of the insulator.

The pin is made of either cast-iron or malleable-iron to suit the purchaser's conditions. While designed particularly for use with wooden cross-arms, it can readily be adapted to steel cross-arms or to special fixtures. A dozen or more standard sizes of the new pin are being worked up, to fit various sizes of cross-arms and pole-tops, and to carry insulators of varying sizes up to the highest voltages in use.

The Smith-Grip pin has several marked points of superiority over previous designs of pin: It leaves the cross-arm of full strength, since it does not require pin-hole or mortise, and avoids the deterioration caused by water collecting in the pin hole; it gives a pin of maximum strength, having largest section near the base where the bending stress is greatest; and it gives an effective means of following up the shrinkage of the wood of the cross-arm.

More than 8,000 of the pins as originally designed (shown in the photograph) were used on the transmission line of the Long Island R. R., carrying 250,000-c.m. cables in spans averaging 150 ft. long. No failures of these pins have been reported after over a year of service.

COAST EROSION AND RECLAMATION in England have recently been described in detail in a series of articles in "The Engineer," of Londca. The total length of coast line from the River Tweed on the east to the Solway Firth on the west is 2,008 miles, and the total area lost during the thousand years from 900 to 1900 is about 524 sq. miles, the average rate of recession per annum being from 0.10 ft. to 7 ft. in different parts, with a general average of 1.4 ft. At individual points, however, the rate of erosion is very much greater than the highest average given. To offset this loss, however, not only have extensive protection works been constructed to check the erosion, but large areas of land have been reclaimed along the shores and at the mouths of rivers. About 400 acres were thus reclaimed as long ago as the Roman occupation of Great Britain, and between the years 900 and 1900 no less than 1,277 sq. miles have been thus reclaimed.

The "Smith-Grip" Insulator Pin.
Original design, as used on power transmission line of Long Island R. R.

RECONSTRUCTION OF THE ATLANTIC CITY "STEEL PIER" IN REINFORCED CONCRETE.

The "Steel Pier" at Atlantic City, N. J., was built in 1897-8. It was constructed of transverse rows of 10 in. diameter, ⅜ in. thick steel pipe and riveted posts of two 8-in. 13.75-lb. channels and two 10 × ⅝-in. plates, with cast-iron disks 3 ft. in diameter for bearing shoes carrying transverse plate girders and plate girder longitudinal struts of wrought steel. The metal work, unprotected except by paint, rapidly corroded and in 1905 the corrosion, especially of the steel members, was so bad that the cross-sections of all members had been reduced from one-fifth to one-third. Reconstruction was decided upon, and at the same time it was decided to enlarge the pier by widening certain portions. To reconstruct the pier in steel meant simply that a few years hence the rapid corrosion would again necessitate reconstruction, and after considering various plans it was determined to build the new portions in reinforced concrete and to encase the old piles and girders in concrete, also reinforced sufficiently to take all stresses independent of the embedded frame. The task of working out the design was turned over to the Concrete Steel Engineering Co., of New York City, whose engineers developed the plans that will be described here.

ORIGINAL PIER STRUCTURE.—The diagram plan, Fig. 1, shows the outline and dimensions of the original pier and of the additions that have been made to its area. Briefly, the original 119,146 sq. ft. area has been increased 38,063 sq. ft., making the present area 157,209 sq. ft. The structural work of the old pier was about as follows: Under the Music Hall, Sun Parlor and Ball Room steel pipe piles on cast iron disks were sunk on the spacing shown and connected by transverse and longitudinal 12-in. steel girders forming the floor framework. At a level 12 ft. below these tops the piles were braced together transversely by latticed struts. In each transverse bay a knee brace extends from the ends of the transverse struts to the mid-span point of the floor girder above. The piles were all 10¾ ins. outside diameter. Under the 40-ft. promenade connecting the ball room and sun parlor were two rows of riveted post piles 20 ft. apart in both directions; these piles carried 24-in. transverse riveted girders cantilevered out 10 ft. at the ends and also were connected by longitudinal struts. The transverse bracing below the floor framework was much the same as that under the portions previously described. Under the Entrance Hall and 75-ft. promenade the structure consisted of steel pipe piles spaced 20 ft. in both directions connected by arched angle knee braces and carrying the regular transverse and longitudinal girder floor system.

The new work consists of the additions shown by the broken lines; the placing of additional piles under the Music Hall, and the encasing of all the original metal work, omitting the knee braces and struts, in concrete. The additions consist of transverse and longitudinal girders in reinforced concrete carried on reinforced concrete piles 12 ins. in diameter under the promenade and ball room portions and 25 ins. in diameter under the Music Hall. The casing of the steel pipe piles will also be 25 ins. in diameter. The view Fig. 2 indicates quite clearly the new work in reinforced concrete. A description of the essential details follows:

WORK ON 12-IN. PILES.—The new work for which 12-in. piles were used comprises the additions to the ball room and 75-ft. promenade portions of the pier. The standard girder and pile construction is shown by Fig. 2 and in detail by Fig. 3. As will be seen, the piles are 12 ins. in diameter with a bulb-shaped point and a special top section designed to knee brace the attached transverse and longitudinal girders. A 2-in. diameter jet pipe extends the full length of the pile and the concrete is reinforced by six vertical bars which are splayed out at the bottom to reinforce the bulb point, and also at the top to reinforce the knee braces. The girder reinforcement is clearly shown by the drawings.

In construction these piles were molded on end in wooden forms set on small pile platforms built adjacent to the locations of the piles in the pier, as shown by Fig. 4. The piles were molded with shaft, bulb point and knee braces complete. After hardening, the piles were lifted from the platforms on which they were molded, set in position and sunk into the sand by means of a water jet, having a pressure of 65 lbs. per sq. in. When sunk the girder molds were built resting on the pile tops, and the girder reinforcement and concrete were placed. The view Fig. 4 shows at the right hand end a girder form in place; further along two piles are shown jetted down and thence on the view shows the piles with the forms stripped off but still standing on the platforms on which they were molded. In the view, Fig. 2, is shown at the far end the movable tower for handling the piles and supporting them during sinking. The piles were sunk from 8 ft. to 14 ft. into the sand and had a maximum length of 32 ft. 6 ins. The bearing power of the sand was taken as five tons per square foot.

FIG. 2. VIEW SHOWING ADDITION TO WIDTH OF PIER CONSTRUCTED OF REINFORCED CONCRETE PILES AND GIRDERS.

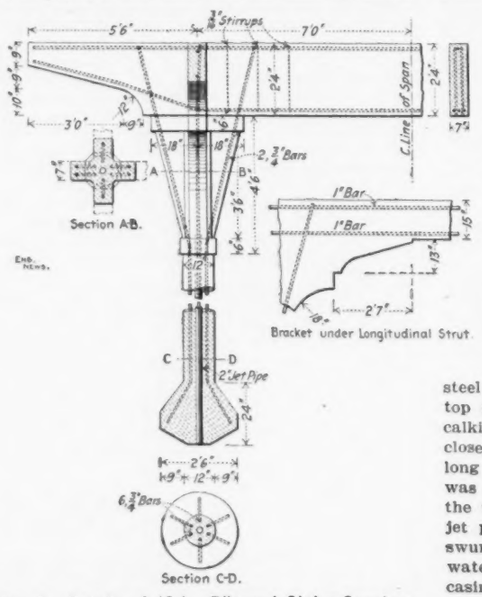


Fig. 3. Details of 12-In. Pile and Girder Construction in Reinforced Concrete.

WORK ON 25-IN. PILES.—The new work for which 25-in. piles were used was the work under the Music Hall in deeper water and where the piles were to be carried down 16 ft. into the sand. The pile and girder structure was substantially similar to that already described, and is shown in detail by Fig. 5. The method of molding and jetting larger piles differed considerably, however, from that previously described.

The bottom 12-ft. of the large piles, including the bulb points, were molded in wooden forms with the jet pipe and reinforcing rods in place, as shown by Fig. 6. When this section of concrete had hardened a ⅛-in. galvanized sheet steel shell was slipped a little distance over its top and the joint made water-tight by oakum calking. The steel shell was made water-tight by close riveting and by calking all joints and was long enough to reach above water when the pile was sunk to position. The casing being placed, the upper reinforcing rods were hooked on, the jet pipe was extended and the pile and casing swung into place and jetted down with 85 lbs. water pressure. When down to position the casing was filled with concrete, and in the same way the bracketed top was molded. The longest of these 25-in. piles were 52 ft. from the top of girders.

ENCASING STEEL PILES.—The original steel piles of the steel pier had 10¾-in. shafts resting on a spherical bottomed cast iron disk 3 ft. in diameter as shown by Fig. 7. The plans were to encase these piles with hollow reinforced concrete piles, as also shown in Fig. 7. The difficulty of the task lay in performing it with the

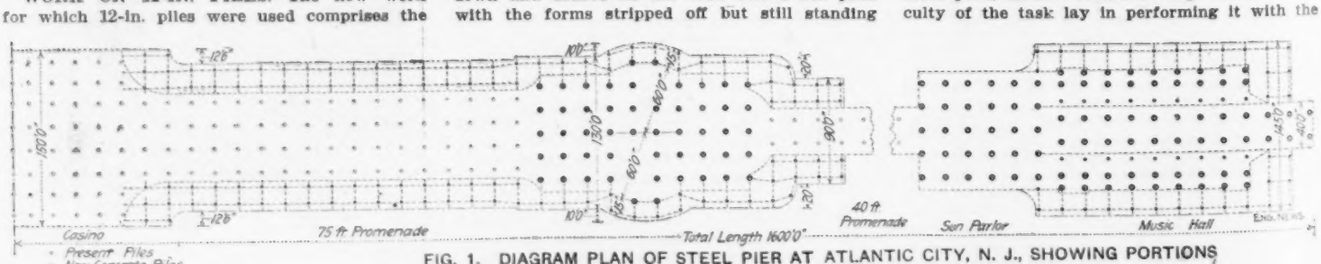


FIG. 1. DIAGRAM PLAN OF STEEL PIER AT ATLANTIC CITY, N. J., SHOWING PORTIONS RECONSTRUCTED IN REINFORCED CONCRETE.

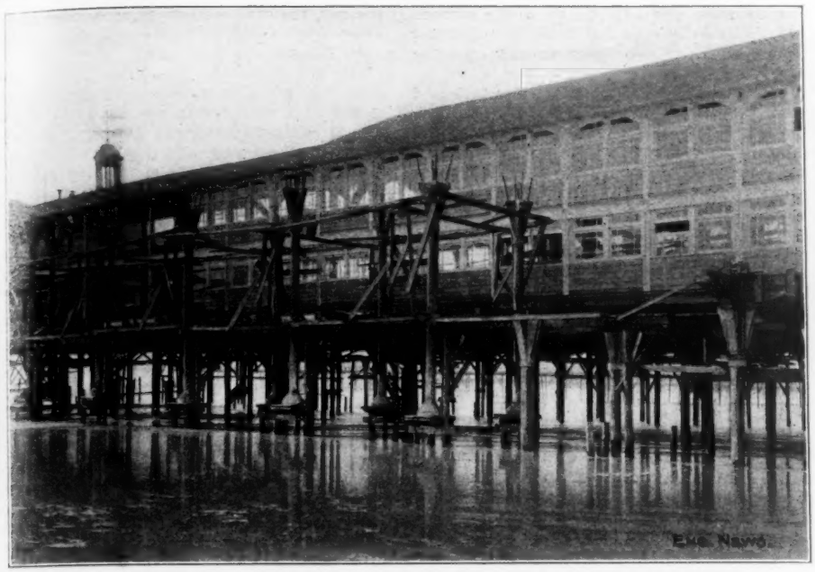


FIG. 4. VIEW SHOWING 12-IN. REINFORCED CONCRETE PILES ON MOLDING PLATFORMS.

steel pile surrounded by water and sand. The method adopted was as follows: The base section of the annular concrete pile was molded around the top of the steel pile in a wooden form having a sheet steel inner shell or jacket to prevent the concrete from adhering to the steel pile. This base section was then slipped down the steel pile until another section of wooden form and steel jacket could be attached to the concrete; the concrete was slipped down further and another section of form was added, and this operation was repeated until the concrete base struck the sand bottom, when the water jets were put in operation and sinking continued until the concrete base rested on the cast iron disk. The annular space in the form of steel plate shells was then filled with concrete, completing the pile. The method of embedding the girders was simply to box them around, place the reinforcing rods and then deposit the concrete.

GENERAL REMARKS ON CONSTRUCTION. —The work of rebuilding the pier was commenced on Dec. 18, 1905, and the first concrete pile was cast on Dec. 31, 1905; the last of the concrete was put in place on July 18, 1906. Owing to the break of the sea waves occurring underneath the ball room this portion of the work was found to be most difficult, since, it being carried on during January, February and March so as to have the building ready for the spring business at Easter time, the workmen suffered considerably from the cold and from getting wet by the spray from the waves breaking over the piling and bracing. It is stated that this portion of the work will run from 40% to 50% higher in cost per cubic yard of concrete in place than the work done in good weather. All scaffolding for carrying workmen and supplies was suspended from wire cables from the pier deck so that it could be hoisted from danger of being washed away by high running seas. In spite of this precaution a good bit of scaffolding and temporary trestling was washed out at times. This was deposited from half to three-quarters of a mile down the beach, whence it was recovered by men and teams. During March the seas run so high that men were able to work below the pier deck in setting forms and concreting only eight days. As the full force could not be given work above deck this meant heavy expense from time lost. The force employed varied from 50 to 180 men, the latter number being employed from April 1 to June 1, when all parts of the work could be carried on to the best advantage. In jetting down the piles for the Ball Room, Music Hall and Sun Parlor the men were worked day and night shifts so as to take full advantage of low tide periods. For night work electric lights were suspended between each row of columns.

The concrete used was a mixture of 1 part Vulcanite Portland cement, 2 parts fine and coarse sand mixed and 4 parts gravel 1 in. and under in size. No local beach sand was permitted to be used on account of being too fine. The concrete was mixed wet. It was puddled into the pile forms by means of bamboo fishing poles, which were found very successful in getting a good mortar surface and in working the mixture between the reinforcing rods and the face of the form. All concrete was deposited in small quantities and well puddled. About 75% of the concrete was mixed by machine set up in two locations on the work and was wheeled to place in barrows. The balance was mixed by hand in small batches.

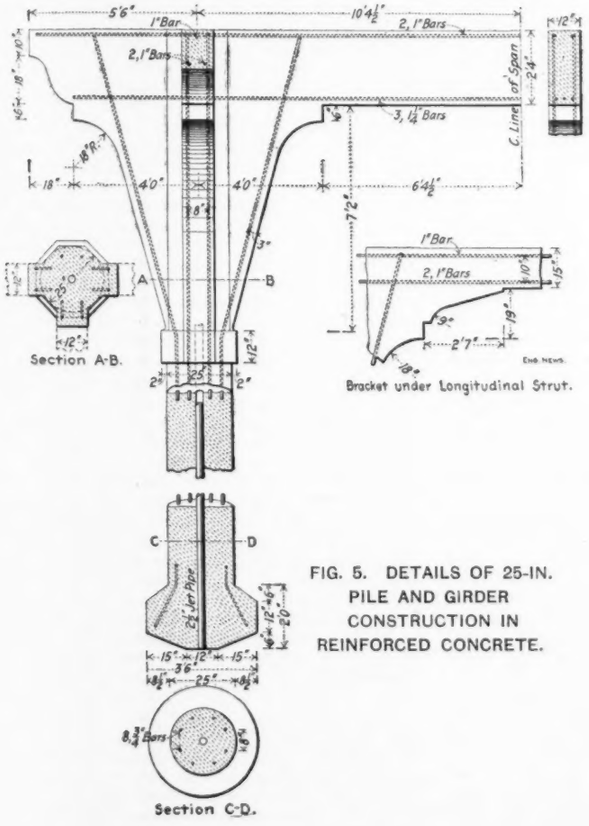


FIG. 5. DETAILS OF 25-IN. PILE AND GIRDER CONSTRUCTION IN REINFORCED CONCRETE.

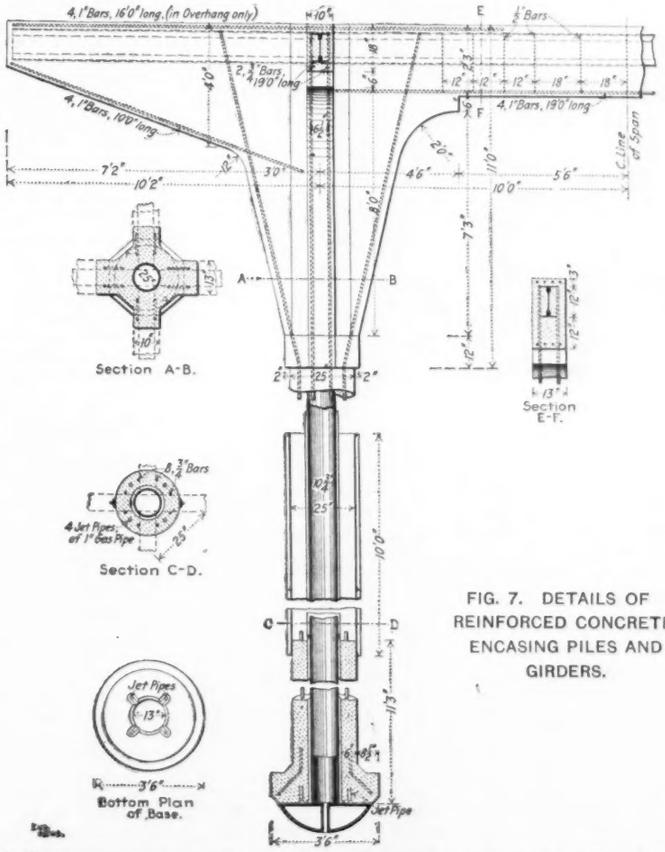


FIG. 7. DETAILS OF REINFORCED CONCRETE ENCASING PILES AND GIRDERS.

In making the 12-in. piles the forms were removed in from five to seven days, depending on the weather. In order to expedite the work, the 25-in. piles (excepting 34 outside ones which were molded in galvanized steel shells) were jetted down with the 2-in. wooden covering left in place. It was possible thus to sink the piles when only 24 hours old. In a word all 25-in. piles except the 34 with galvanized steel shells will have the 2-in. wooden forms left in place from the pile cap to within 10 ft. of the shoe until it shall be destroyed by the elements. The wooden casing is secured every 3½ ft. by 1¾ × 5/16-in. steel bands. All of the annular concrete piles encasing the original steel piles also have the wooden forms left in place. The idea of this was to have the concrete armored against abrasion until it had become thoroughly hardened.

The piles were handled by a derrick and block and fall. The progress of jetting varied greatly on account of encountering many obstructions in the shape of logs, old iron pipes, etc. In some cases three days working all the time of low tide were required to remove one piece of pipe. Generally speaking, working 1 foreman and 6 men, the progress of sinking, if no obstructions were encountered, averaged about 8 ft. per hour for 12-in. piles and 6 ft. per hour for 25-in. piles.

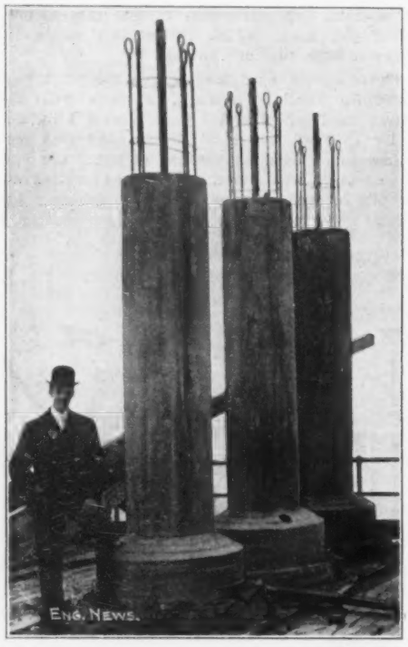


Fig. 6. View Showing Base Sections of 25-In. Piles.

An attempt was made last summer (1905) to clean and paint the structural steel work of the old pier, and it was found that after the workmen had cleaned and painted one coat, by working in from the sea end of the pier, the paint would be nearly all washed off by the spray from the sea waves before it had time to become dry. The painting was abandoned for this reason after working in for some 200 ft. from the sea end.

It is of interest to note that the piling that has been in the sea for the past six months is covered with a coating of organic and inorganic nature which seems to close the pores and will in time form a protective coating of considerable thickness, which will exclude the sea water, and prevent any disintegration of the concrete.

An experimental set of piling was made a year ago of 1-3-7 concrete, and three piles were placed in the sea at a point on the beach where the concrete was subjected to the wash of the full tide. An examination of this piling after being exposed for eight months showed it to be covered with a growth of inorganic matter forming a protective coating for the concrete. The concrete showed no sign of any wearing away from the action of the sea. Steel bars were embedded in these piles 1½ in. from the surface. An examination showed the bars, on removing the concrete, to be even brighter and smoother than when embedded.

Only that portion of the original pier indicated in Fig. 1 has been reconstructed as described, but it is the intention to similarly improve the remainder at the end of the present season. When entirely reconstructed the pier will be to all intents and purposes a reinforced concrete structure, since the encasing piles and girders of concrete have been designed to take full load independent of the original metal structure. In conclusion it should be noted that the work described has all been done by C. W. Snyder & Co., Contractors, of Atlantic City, N. J., under the supervision of Mr. D. A. Keefe, Resident Engineer, Atlantic City Steel Pier Co.

METHODS OF HANDLING SNOW ON ELECTRIC RAILWAYS.

With the establishment of electric interurban railways, built in open country, and running cars at intervals of 15 to 60 minutes, the engineering, mechanical and operating departments of electric railways have had to face special problems of snow removal and blockades, different from those encountered on city and suburban streets with a more frequent service. Some inquiries received during the past winter have led us to investigate the practice and experience of such railways in regard to these problems, but the winter has been so mild that in most sections of the country there has not been any serious trouble from snow.

In the first place, electric railways are at a disadvantage as compared with steam railways in that snow or sleet collecting on the trolley or third-rail may materially reduce the power just at the time when the condition of the track rails makes it necessary to have ample power for propulsion, in order to drive the car over the wet and slippery rails and through the drifts. As far as the trolley wire is concerned, the usual practice is to attach to the trolley pole a curved blade or scraper which bears against the wire and scrapes off the snow or sleet; or else to replace the ordinary trolley wheel with a special wheel having ribs or lugs formed in the groove which cut the coating of sleet and jar it loose. On lines having the third-rail conductor, the general practice is to equip the trucks with wire brushes or with scrapers formed of vertical steel blades set diagonally across the rail head. In some cases these are supplemented by a calcium-chloride solution fed in a small stream upon the third-rail by a pipe in advance of the contact shoe. As the third-rail is elevated above the track it is not apt to be buried except in the case of very deep or drifting snow. As a matter of fact, trouble of this kind either from sleet or snow, seems to be very much less than might be expected, although for a short period it may be quite serious.

Interesting tests of the relative advantages of different arrangements of third-rail conductors, in regard to the effect of snow and sleet, were made a few months ago with one of the new electric locomotives of the New York Central Ry., on a stretch of track at Schenectady which is equipped with these different arrangements for experimental purposes. The snow test was made on Feb. 9, when the track was covered with about 13 ins. of snow, burying the third-rail. The flanger or pilot snow plow attached to the engine, for the purpose of clearing the track, did not throw the snow clear of the third rail, and it is probable that some special form will have to be devised for the engine plow. With the over-running arrangement, in which the contact shoe rides on top of the conductor rail, the trouble increased with each trip, this being due to the arcing which occurred at intervals, thus melting the snow and causing a layer of ice to form on the rail. This was the experience on unprotected rails as well as on rails with different arrangements of top and side protection boards, and the shoes arced badly on both the unprotected and the protected rails. With the under-running system, in which the shoe rides on the bottom of the rail, the shoe cleared the snow from the rail, and snow melted by occasional arcing drained away, leaving the rail clean.

The test under sleet conditions was made on March 3, when, with occasional light rain, an east wind and temperature of 28° to 33° F., sleet formed all day, its average thickness being about ¼ in. On the unprotected third-rail with contact shoe running on top of the rail, the coating of sleet was so heavy and continuous after a few hours that attempts to run on this section of the test line were abandoned. Where the same arrangement of rail was protected by an inclined plank over the top, but with the side exposed to the wind, the sleet in some places formed entirely across the head of the rail, resulting in serious arcing of the contact shoes. With the under-running arrangement, in which the contact shoe rides on the bottom face of the rail, the sleet dripped off of the enclosing boards and off the edges of the rail, no sleet forming on the contact face of the rail, and there was no sign of arcing at the contact shoes.

For cleaning the track proper, the regular cars may be fitted with scrapers and flangers or pilot plows, and the equipment usually includes some special cars fitted with nose plows or side leveling boards. In a very large number of cases the railways design and build their own special equipment for handling snow. Sweeper cars with revolving brooms are generally used on city and suburban lines, while a few interurban lines have rotary snow plows for handling deep snow. Fig. 1 shows a baggage and express car of the Olean Street Ry., Olean, N. Y., fitted for use as a snow plow and snow spreader. At each end is a nose plow, backed with oak timbers and attached to the body by four guide posts, upon which the plow has a vertical movement of 9 ins., being adjusted by means of chains passing over sheaves upon shafts in the car; these shafts are operated by gearing from horizontal hand wheels. The spreader or leveler on each side is 7 ft. long, attached to a post at the middle of the body, and securely braced.

The rotary snow plows above referred to are on the same general principle as those used on steam railways, but have a smaller number of cutting blades. At the front end (or sometimes at both ends) of the car is a vertical wheel resembling a screw propeller, and revolving on a plane transverse to the axis of the track. The four blades are nearly flat, but set at such an angle as to slice off the face of the snow bank or drift, delivering the snow to a rapidly revolving fan-wheel behind the cutter-wheel; the centrifugal force of the fan throws the snow to a distance of 5 ft. to 60 ft., depending upon the density of the snow, the power of the motors and the speed at which the plow is run. This machine is known as the Ruggles plow and the American patents are owned by the York Steel & Foundry Co. (lessee of the Peckham Mfg. Co.), Kingston, N. Y. About 100 of these machines are in use in this country, and there have been a number built in Canada. The company states that both four-wheel and double-track machines are built; the former are 25 ft. long and weigh about 11½ tons; the latter are 43 ft. 6 ins. long and weigh about 21 tons. There is a motor to each axle, the motors being geared low, and ranging from 35 to 50 HP. There are two motors on the fan shaft; these are high geared, and should not be less than 50 HP. The diameter of the plow wheel is 7 ft. 6 ins. Notes on the use of these machines on the Boston & Northern Electric Ry. and the Houghton County Electric Ry. will be found further on, and Fig. 2 is a view of the double-truck rotary snow plow on the latter road.

City and suburban cars are very generally equipped with track scrapers, having a shoe or blade just in front of the wheels. These not only serve to remove the snow after light falls, but also keep the rails clear during heavier storms after the sweepers have passed over the track. They can be raised or lowered by a lever on the motorman's platform, and are sometimes made so as to clean out grooved rails. They should be mounted on the truck frame rather than on the underframe of the car body, as they will then be practically free from vertical move-

FIG. 1. SNOW PLOW AND SPREADER CAR; OLEAN STREET RAILWAY, OLEAN, N. Y.

ment and will remain in proper position with relation to the rail; if attached to the car body they will swing away from the rails on curves. The use of scrapers is not so general on interurban roads, where the rails are above the surface of the ground.

Electric interurban railways usually follow the surface of the country more closely than steam railways; consequently their cuts are generally comparatively shallow, and the snow-drifts in them are not so heavy. On the other hand, the cuts are often narrow, with steep slopes, which conditions encourage the formation of drifts and add to the difficulty of removing them. Many electric railways of this class, therefore, employ snow fences to a greater or less extent for the protection of cuts and other places liable to trouble from drifts. For clearing snow from frogs, switches and special work, and also along grooved rails, salt is used liberally by some roads and sparingly by others; city authorities usually object to its use, as making a bad, slushy mixture, injurious to public health and also causing injury to the hoofs of animals.

The system of organization for dealing with snow varies very considerably; the track, mechanical and operating departments each having a share of the responsibility. We give below particulars as to the methods and equipment employed by a number of railways in different parts of the country:

ROCKLAND, THOMASTON & CAMDEN ELECTRIC RY. (T. Hawken, General Manager, Rockland, Me.).—This system has 22 miles of lines in streets and 16 miles of interurban line. Heavy snow has to be encountered, sometimes in 10 ft. drifts, and flange scrapers and nose plows are employed, while the regular cars are equipped with track scrapers. Portable snow fences are used on the open line. Special trolley wheels are employed to break sleet from the wire, and salt is used at switches and frogs. The snow plows are home-made. The work of keeping the road clear is in charge of the track foremen.

BOSTON & NORTHERN STREET RY. (Thomas Lees, Superintendent, Lowell, Mass.).—The entire system has 485 miles of track; the Northern Division has 230 miles, of which 150 miles are in streets and 80 miles interurban. There has been very little snow during the past season, but there was a fall of 10 ins. on March 15 and 11 ins. on March 22. The two previous seasons were very severe, with 5 to 6 ft. of snow. Ordinary nose plows are used on single track, and steam plows on double track, while Peckham rotary plows are used to clear the interurban lines when necessary. These rotaries are mounted on double truck cars 40 ft. 9 ins. long, and weigh about 28 tons; the cutting wheel is 8 ft. 2 ins. diameter, and is driven at a speed of 450 to 650 revolutions per minute. The cars are equipped with track scrapers, and sleet wheels are used to clean the trolley wires. The flangeways of T and girder rails are cleaned by the car scrapers. The road has a small amount of grooved rail which gives considerable trouble with snow, but the endeavor is made to keep this soft by the use of salt. The salt is also used at switches and frogs, but rarely on the ordinary track except where grooved rails are used. Snow fences are used on the interurban lines. At the beginning of the winter a list is prepared of motormen who are to handle the plows, each man being assigned to a route.

UNITED TRACTION CO (E. S. Fassett, Superintendent, Albany, N. Y.).—This road has 80 miles of track in streets and 5 miles of interurban lines. Snow plows and track sweepers are used, while the regular cars are equipped with flangers, and frequent service is relied upon to keep the trolley wire free from sleet and snow. The snow plows, etc., are all built at the company's shops. The lines are operated in four divisions, with cars running from four car houses. When 1 in. of snow has fallen, the sweepers are sent out from each division, and run on a regular schedule until the snow stops; when the snow gets too heavy for the sweepers the plows are substituted. There are enough sweepers to cover the entire system in 1¼ hours, and with the plows in addition it can be covered in ¾ hour. By running these machines on a regular schedule, the division superintendent knows at all times where his equipment is, and in case of a breakdown can send out a substitute.

LACKAWANNA & WYOMING VALLEY RY. (Chester P. Wilson, Superintendent, Scranton, Pa.).—This is a double-track, third-rail interurban line, 20 miles long. It has not had much trouble from snow, the depth of snow being only about 12 ins. No snow fences are used. A modified Priest snow flanger is used to clear the track, but no scrapers are applied to the regular cars. Salt is used on the track. There is some overhead trolley wire, but this has not required to be cleaned of snow or sleet. The third-rail is cleaned with steel brushes and a solution of calcium chloride of 1.30 specific gravity. The solution is carried in 15-gallon cans (like milk cans) each fitted at the bottom with a pipe having two branches with globe valves. When the can is set in place on the motorman's cab, the ends of the branches fit into sockets having ¾-in. pipes and rubber tubes leading to each side of the front truck. Attached to the beam carrying the collector shoe on each side is a brush of steel wire, with a hollow vertical stem to which the rubber tube is connected. When sleet forms on the rail, the valve is opened to allow the chloride to flow slowly through the brush upon the rail, the sleet being at once softened by the liquid and removed by the wires of the brush. On the rear truck is a Hedley scraper in place of the brush; this has five or six vertical steel plates set diagonally across the rail and held against it by a spring. As to the organization, the roadmaster operates the flanger and clears the station platforms, the electric line foreman looks after the use of the calcium chloride and the clearing of the third-rail; the trainmaster furnishes them with the necessary crews.

DETROIT UNITED RY. (J. Kerwin, Superintendent of Tracks, Detroit, Mich.).—This system has about five miles of line in streets and 32½ miles of interurban lines; the maximum depth of snow during the past three years has been 2½ ft. on the former and 4 ft. on the latter. On city lines, the regular cars have trailing snow-boards attached to the rear end of the truck, and each line has a leveler for clearing the snow to a distance of about 12 ft. from the rail. Each interurban line has a large construction car which is equipped with a plow and side-wings for leveling the snow for about 12 ft. from the rail. The plow is handled by an air hoist, and the car is ordinarily employed in handling heavy freight and for wrecking purposes. All the city and interurban cars have snow scrapers, and in heavy sleet storms the cars are run all night, in order to keep the ice broken. Snow fences are used when the snow is likely to drift very badly. The trolley wire is cleaned of sleet by a grooved piece of brass which is used instead of a trolley wheel and scrapes the wire. There is some grooved rail, and this gives trouble, although the points of the scrapers, on the cars project down into the groove. Salt is used only at frogs, switches and special work. All the snow plows were built at the company's shops. In the organization for the city lines, the track department has division track foremen, who are assigned to certain districts, and they see that all switches and special works are salted and cleaned; the operating department sees that the snow boards are put on the regular cars, and operates the snow levelers. On the interurban lines there is a roadmaster who has charge of all snow cleaning.

MARQUETTE CITY & PRESQUE ISLE RY. (Hamilton Baluss, General Manager, Marquette, Mich.).—In this part of the country the snowfall is very heavy, from November to April. A considerable amount of portable snow fence is used, made in sections 14 ft. long and 5 ft. high, with 4-in. spaces between the boards. The fences are placed about 75 ft. from the track. A rotary sweeper is used in the city and a snow plow outside, and all cars are provided with scrapers. The sweeper has a side plow or leveling board which will level off 10 or 12 ins. of snow for a width of 10 ft. 6 ins. from the rail, with car running at six miles an hour. To level the hard ridge of snow which often packs between the rails a heavy road scraper is used, having flanges bolted to the wheels and a pole by which it can be attached to a car. The machine is well weighted with iron. The snow plow for lines outside the city is a four-wheel car with a high iron plow in front, like those sometimes attached to a steam locomotive, and reaching to within a few feet of the top of the car. It is heavily backed by oak timbers, and the machine, heavily weighted with iron, can handle drifts 5 ft. deep. Salt and sand are used as sparingly as possible, as it is injurious to track, motors, wiring, etc. There is one very heavy grade, and the best results on this are obtained by using no salt and using sand only when absolutely necessary; if salt is used, the adhesion is reduced for a long time. At switches and special work a little salt is used when the rails cannot be kept open otherwise.

HOUGHTON COUNTRY STREET RY. (W. H. McGrath, Manager; Geo. W. Rounds, Superintendent, Houghton, Mich.).—There are about 13 miles in streets and 13.20 miles of interurban line. During the past winter the maximum snowfall has been 11 ins., and the total fall 6 ft.; during the previous five winters the maximum for each fall ranged from 10.3 to 14.7 ins., and the total depth from 7 to 15 ft. Single-truck nose plows are used in the towns and heavy double-truck nose and rotary plows on the interurban lines. The rotary plows include a double-truck machine and a four-wheeled machine; the former is 36 ft. long and weighs 25 tons, the latter is 25 ft. long and weighs 15 tons. In the larger machine, illustrated in Fig. 2, there are four 50 HP. motors to drive the axles and two 50 HP. motors to drive the fan, which is 7 ft. diameter. The speed of the fans varies with the voltage and with the amount of snow thrown, but the snow is easily thrown to a distance of 50 ft. These rotary plows are only used for drifts, as they travel slowly. Horse scrapers are used in the main streets. All cars have scrapers, but no flangers, and one has a plow. Snow fences are used. There is not much trouble from sleet on the trolley wire, but the trolley wheels are renewed and a U-shaped scraper also sometimes used. Salt is used only at frogs and switches. In operation, regular crews are assigned to the plows, and the inspec-

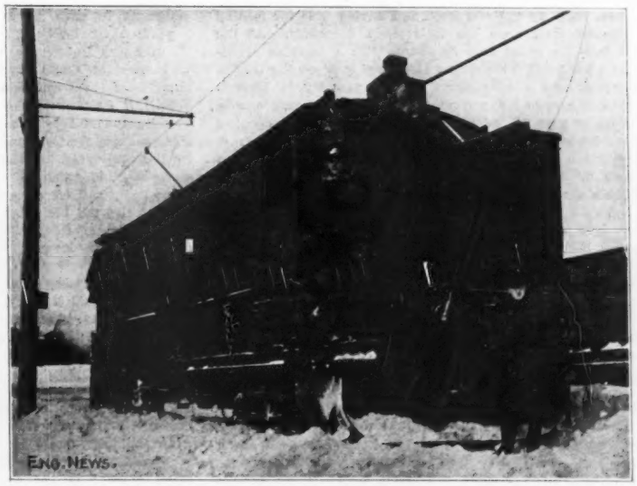


FIG. 2. ROTARY SNOW PLOW, HOUGHTON COUNTY STREET RAILWAY, HOUGHTON, MICH.

York Steel & Foundry Co. (Lessee of Peckham Mfg. Co., Kingston, N. Y., Builders.)

tor on each division has charge of their movements; four men constitute a crew for the rotary plows, and three men can handle the other plows, which have heavy wings.

AURORA, ELGIN & CHICAGO RY. (D. D. Miles, Master Mechanic, Wheaton, Ill.).—This is a high-speed third-rail line with about 90 miles of track. It has had very little trouble with snow, and has only an express and milk car fitted with small snow plows. For cleaning snow from the third-rail, steel brushes are mounted ahead of the contact shoes. For sleet, a solution of calcium chloride is carried in 30-gallon tanks on the cars, and delivered to the third-rail through pipes to a steel brush, as above described for the Lackawanna & Wyoming Valley Ry. Mr. Miles has also invented a sleet cutting device consisting of a horizontal revolving disk with cutters on the lower face; this is driven by power and held upon the rail by a spring. No flangers are used on the regular cars.

DANVILLE STREET RY. and DANVILLE, URBANA & CHAMPAIGN RY. (L. E. Fischer, General Manager, Danville, Ill.).—These lines, with 17 miles in streets and 61 miles of interurban line, have little trouble from snow, the depth being about 2 ins. Scrapers are used on a few cars, and sleet cutting wheels to clear the trolley wire. Salt is used to clean the flangeways and to clear switches, frogs, etc.

INTERURBAN RY. (H. H. Polk, President and General Manager, Des Moines, Iowa).—There are 6½ miles of line in streets, and 66 miles of interurban lines. During the past three years there has been a great deal of snow, sometimes 14 to 15 ft. deep on the country lines. Snow fences are used to some extent. In the streets, the work is done by the Des Moines City Ry. On the interurban lines, the electric locomotives are used, with a large nose plow operated by air. The regular freight crews operate the plows, and each plow carries four or six section men. Some of the older cars are equipped with scrapers, but these are considered dangerous and are to be removed. A sleet-cutting trolley wheel is used. Salt is applied only at switches, frogs and special work.

WATERLOO, CEDAR FALLS & NORTHERN RY. (C. D. Cass, General Manager, Waterloo, Iowa).—This road operates 12 miles in city streets and 24 miles of interurban line (besides 50 miles of steam railway). On the streets, the practice is to couple two or three cars together, and attach to the front car a snow plow about 2 ft. high, which rides on the rail. The local cars are equipped with snow scrapers. For the interurban lines, a pilot snow plow is attached to an electric locomotive, the method being similar to that employed on steam railways. There is not much trouble in the cities, but on the interurban lines there are heavy cuts which sometimes fill with snow to a depth of 10 or 12 ft. Snow fences are used as in steam railway practice, and are put up on the north and west sides of every cut. There is very little trouble from sleet, and while the first car is apt to be considerably delayed, it cleans the wire and the following cars have no trouble. All lines are laid with T rails, and salt is used to melt the snow in the flangeways and also at switches, frogs, etc. The work is in charge of the trainmaster in cities, and the roadmaster on the interurban line.

DULUTH STREET RY. (Herbert Warren, General Manager, Duluth, Minn.).—This company operates tracks on 27 miles of streets in Duluth and 13 miles in Superior. The average depth of snow is 6 to 12 ins., but sometimes the drifts are high enough to cover the cars. Many miles of snow fences are used in the outlying districts. All snow clearing is done by two heavy double-truck snow plows, built by the company, and having bins for feeding salt and sand upon the rails when necessary. At the front is the usual nose or share, with a movable extension on the left for clearing the space between the tracks. There is also a wing about 8 ft. long and 2 ft. high to throw the snow away from the tracks. The nose can be raised or lowered and the side wing drawn out or dropped back by means of gears and hand wheels controlled from the inside of the car. There is not much trouble from snow or sleet on the trolley wire, but special trolley wheels are fitted to a few cars on each line when necessary. All the cars are equipped with scrapers in front of the first truck, being raised and lowered by a lever or wheel in the motorman's cab. Salt is used at switches, etc., and occasionally on the track, especially on grades. It is only used on the tracks when absolutely necessary, as the public and city officials object to it, although Mr. Warren believes this is without good reason. Men in the repair shops operate the snow plows, assisted by extra conductors, or motormen, or track laborers.

QUEBEC RAILWAY, LIGHT & POWER CO. (Edward A. Evans, General Manager and Chief Engineer, Quebec, Canada).—This road has about 17 miles of line on streets and 30 miles (7 double-track) of interurban line. The average snowfall for the past ten years has been 100.4 ins. For work in the streets there are six rotary sweepers with rattan broom, and wing plows which scrape down and throw back the snow for a width of about 10 ft. For interurban work, there are two ordinary steam railway snow plows, with wings; flangers and scrapers are also used. The city cars have flangers and scrapers; the interurban cars have small snow plows and flangers. Special sleet-cutting trolley wheels are used to clear the wires. Grooved rails are only used at sharp corner curves and give no trouble; the flangeways are kept clear without trouble by the flangers and scrapers on the cars. Salt is used at switches, frogs and special work, and on steep grades.

ELEVATED RAILWAYS.

On electric elevated railways there is as a rule very little trouble from snow owing to the open floor construction, but sleet is sometimes very troublesome, though usually for short periods only. Scrapers and brushes are mainly relied upon to keep the third-rail clean, as the use of thawing solutions might set up corrosion in the metallic structure and the rail bonds, and also be objectionable by dripping upon the streets. For the same reasons salt is used as little as possible for clearing snow at switches, etc. As far as snow is concerned, hand shoveling is commonly resorted to, although cars fitted with scrapers and leveling boards are sometimes used. The practice and experience of some elevated railways are noted below:

INTERBOROUGH RAPID TRANSIT RY. (Frank Hedley, General Manager, New York).—On the elevated lines 60% of the car equipment is equipped with the Hedley patent scrapers, already mentioned, which are used for removing both snow and sleet from the third-rail. No special devices are used for clearing snow from the structure. There are several places where the line has a solid deck and rock ballast, but no special devices are used for keeping the snow off these sections of the road.

BOSTON ELEVATED RY. (H. A. Parks, Superintendent).—The length of the elevated structure is 7¼ miles, with 16 miles of track. The equipment for cleaning snow from the tracks consists of a flat car equipped with a projecting frame from which are suspended adjustable arms, attached to which are heavy rattan track brushes which fit between the rails and guards. These are controlled by a man on the car platform, and trail behind the car. For cleaning the cable walk which runs the length of the road between the tracks, a small plow is attached to the above-mentioned flat car, suspended from an arm so adjusted as to compensate for the different distances of the cable walk from the rail. Both snow and sleet are cleaned from the third-rail by means of wire brushes attached to the truck frames, two on either side of each truck of every car. These brushes are so suspended that when not in use they may be raised up off the third-rail. There is very little trouble from snow. Switches and frogs are swept out with rattan track brooms, which are equipped with a chisel on the end of the handle. No salt whatever is used. Sufficient men are stationed at each tower or switch to keep the special work free from snow. There are no snow plows other than the apparatus mounted on the flat car above-mentioned, and this was designed and built at the railway shops. No part of the structure has a solid deck floor except short lengths of about 30 ft. covering passageways at stations. Snow collects at these points in times of heavy storms, and has to be removed quicker than at other points of the structure. The width of space between the rail and inside guard timber is 4 ins. The width of space between the rail and inside steel guard rail varies from 1¾ ins. to 2¼ ins. between the adjacent sides of the heads of the rails. No special device is used to clean the snow out of these flangeways, as there has never been trouble with snow collecting in such places.

METROPOLITAN WEST SIDE ELEVATED RY. (E. T. Munger, Master Mechanic, Chicago).—This road has 38.7 miles of single track. Nothing is done to remove snow from the track proper, but it is removed from the third-rail by means of a wire brush on the car trucks, held to the rail by the pressure of a spring. Sleet is cleaned from the third-rail by means of a scraper handled by the employees. Switches and frogs are kept clean by sweeping, and sometimes a little salt is used where there is no third-rail close to it. The road department takes care of clearing the snow and keeping the switches, etc., clear. The structure has a solid deck floor where it crosses the boulevards, but these points give no extra trouble. The width of the space between the rail and inside guard timber is 4 ins., and between the rail and curve guard rail it is 2¼ ins.; no special device is used to clean out the flangeways.

NORTHWESTERN ELEVATED RY. (R. B. Stearns, Superintendent, Chicago).—This road has 5½ miles of four-track structure and one mile of double-track structure; this is independent of the two miles of the double-track loop. There is no equipment for cleaning snow, as the road is not troubled in this manner, on account of the open deck; there is only approximately 500 lin. ft. of four-track structure with solid deck floor, and this small amount is not specially troublesome in time of snow. Sleet is cleaned from the third rail with a sleet scraper of steel blades mounted on a suitable head with a leaf spring of 250 lbs. tension; this is the Hedley patent. There are four scrapers to each car, mounted immediately in advance of the third-rail contact shoe, and on the same shoe block. This scraper must be raised and lowered by hand. Switches and frogs are cleaned in the usual way with worn out corn brooms and thin steel scrapers; salt is used very sparingly and only during the worst conditions at important points, on account of the deteriorating effect on the bonding and feeder cable terminals. The inside wooden guard rail is 6 × 6 ins., and on tangent track the nearest face is spaced 4 ins. from the gage side of the rail. The outside guard rail is 6 × 8 ins., and the nearest face is spaced 10 ins. from the gage side of the rail. On curved track, the inner rail is guarded by steel guard rail spaced 1¾ ins. to 2½ ins. from the gage side of the rail, depending on the degree of curvature. There is no special device for cleaning out flangeways on the curved tracks, as they give no special trouble.

STEAM MOTOR CARS OF THE PARIS & ORLEANS RAILWAY, FRANCE.

In 1903, the Paris & Orleans Ry. put in service a steam motor car of the Purrey system on the line between La Fleche and Sable, and the experiments have shown that there is no serious obstacle to the operation of a regular service by such cars, and that the cost of operation need be only about 30% of that of operating the same service by trains in the usual way. As a result of the trials, the company ordered ten more cars to establish additional service and to replace light trains. One difficulty has been that the service had to be interrupted whenever the motive power equipment required repair or inspection at the shops, as this equipment was a part of the car, which was carried on three axles mounted in pedestals on the frames. This difficulty can be avoided by making the machine in two parts: 1, a motor truck, with the engine, boiler, fuel and water tanks, etc.; 2, a car body adapted to be carried at the front end by the motor truck and having a trailing truck or axle. This arrangement not only provides for inspection and repairs, but also makes a steady machine which will ride easily around curves. This is the system adopted by the Paris & Orleans Ry., which has ordered two extra steam trucks with its 10 steam cars to allow of the others being overhauled without taking the cars out of service.

These new cars have a four-wheel steam truck at the front end and a single trailing axle, giving a total wheelbase of 37 ft. 5 ins.; this arrangement was adopted to enable the cars to be turned on turntables of 39 ft. 4 ins. diameter. At French railway stations there are usually turntables of about 14 ft. 6 ins. diameter for handling the small freight cars, and these can be made available for turning the new steam cars by laying around the turntable a circular track at the proper distance to receive the trailing wheels. On this track runs a "transporter" or transfer table only a few inches high, with inclines to enable the car wheels to be run upon it. The steam truck, of course, stands upon the turntable. The steam truck can be detached in about 15 minutes: the brake and heater pipes are first uncoupled, and the brake rigging then disconnected by a bolt. The rear wheels being blocked, the front end of the car is raised by a pair of jacks and the truck then run out under its own steam, or by pinch bars or car-movers if the engine is not under steam.

The steam truck (Fig. 1) has side frames of steel plates, connected by three transoms, the middle transom or bolster carrying the pivot and side bearings for the car. The engine and boiler are mounted at the rear end of the truck, leaving the front end free for the cab. The engines, Fig. 2, are placed with the cylinders between the frames and just behind the second axle; each engine has a pair of tandem cylinders, inclined, and driving a crank shaft, at each end of which (and outside the frame) is a heavy 15-in. driving pinion. A sprocket or link-belt chain runs over the pinion and over a 24-in. spur wheel keyed upon the rear axle (between the wheel and the frame). The slide valves are placed vertically between the two sets of cylinders, and are operated by two valve gears of the Stephenson link type. Live steam can be admitted to the low-pressure cylinders in emergency. The engines are very carefully counterbalanced, and the working parts are

enclosed in an oil chamber with splash lubrication. With a gear ratio of 2:3 (28 teeth on the crank-axle pinions and 42 teeth on the spur wheels on the rear axle of the truck) the engine runs at about 500 revolutions per minute for a speed of 40 miles an hour. The maximum speed attained is 52 miles an hour.

The boiler, Fig. 3, is of the Purrey water-tube type, having a rectangular shell placed across the truck, and fired from one side. It has a steeply inclined grate with rocking finger bars, and is automatically fed with coke by gravity, the supply being regulated by a sliding gate.

Electric buttons in the cab and in the compartments enable the engineman and passengers to call the attention of the conductor in the baggage compartment by means of a bell and annunciator. The car is lighted by oil lamps having circular burners, and is heated by exhaust steam circulated through pipes, live steam being admitted when necessary.

Before the cars were put in service a number of trial runs were made to determine their efficiency and to instruct the enginemen. These were made between Bretigny and Dourdan, 15 miles, having grades of 0.5 to 0.8%. The machines hauled a 17-ton dynamometer car, and sometimes one or three 10-ton trail cars, making a maximum load, with the steam car, of 61 tons. In none of the tests was there any heating of bearings, and there was no trouble with the high-pressure cylinders or their valves from the use of superheated steam. The temperature of the steam was from 707° to 797° F. in regular running, and 842° to 855° F. in ascending grades. It was found that the rate of fuel consumption was practically the same as in compound locomotives, in spite of the fact that the air pump represents an important consumption; this high economy is attributed to the use of superheated steam. The tests showed that the maximum power delivered at the rails was 260 HP. and that the machines were easily able to fulfill the requirements, as follows: (1) To haul a 14-ton car (making 48 tons in all) at 40 miles an hour on grades as high as 1.5%; (2) to haul two cars weighing together 27 tons (or 61 tons in all) at 34 miles an hour on the same grades; (3) to haul a 14-ton car (48 tons in all) at 47 miles an hour on lines with grades not exceeding 0.8%.

The above description is condensed from an article in the "Revue Generale des Chemins de Fer" by Mr. Louis Huett, Inspector of Motive Power and Rolling Stock, Paris & Orleans Railway. The dimensions of these steam cars are as follows:

Driving and trailing wheels	3 ft. 6 ins.
Wheelbase, steam truck	10 " 6 "
Wheelbase, total	37 " 5 "
Distance, truck center to trail axle	28 " 4 "
Length over all	55 " 0 "
Width	9 " 4 "
Weight on steam truck	20 tons.
Weight, total	34 tons.
Cylinder, l. p. (2)	6.4 × 9 ins.
Cylinders, h. p. (2)	8.8 × 9 ins.
Boiler, size over casing	5 × 3.28 ft.
Boiler, height over casing	5 ft. 9 ins.
Tubes, diameter, outside	1¾ ins.
Steam drum, diameter	1 ft. 8 ins.

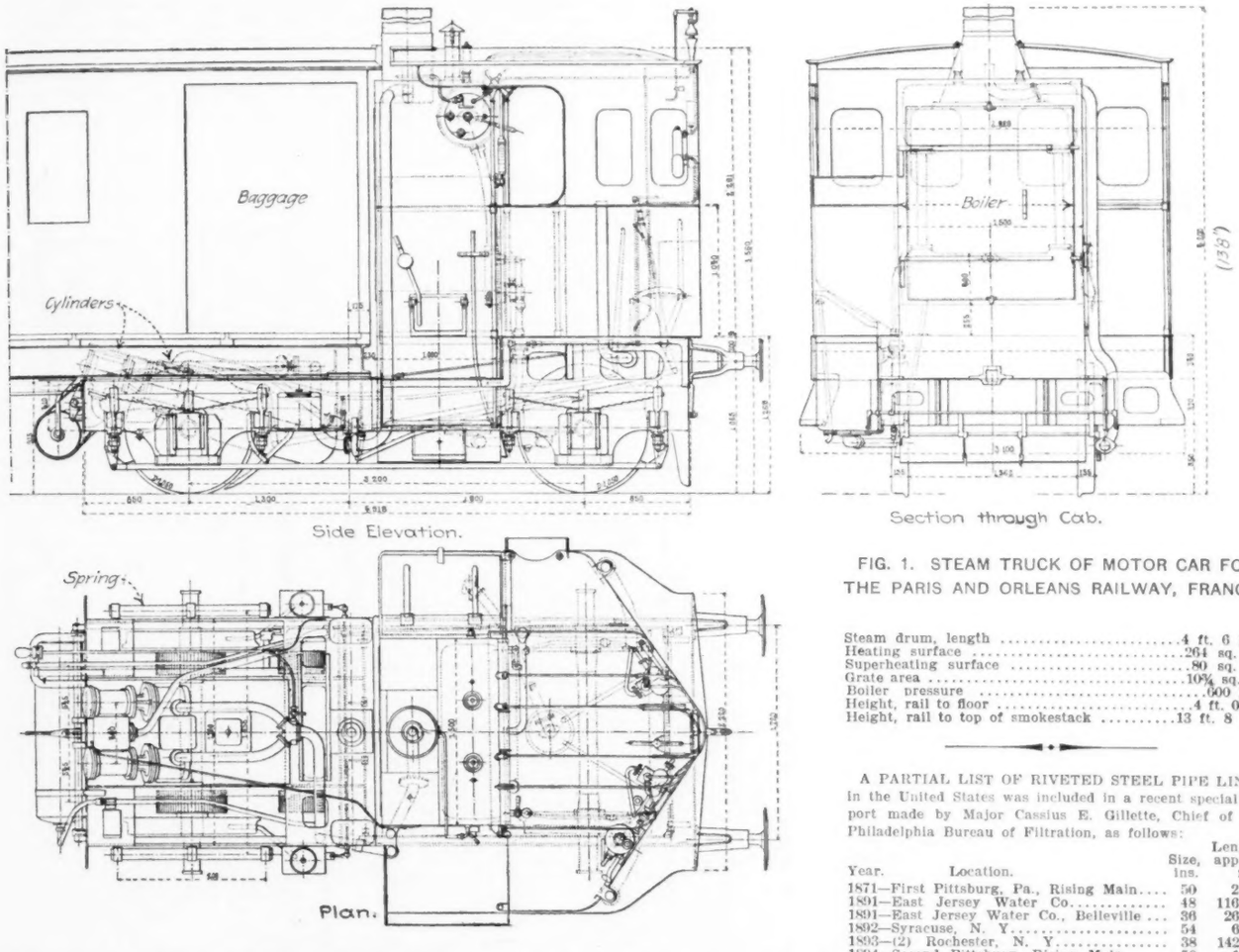


FIG. 1. STEAM TRUCK OF MOTOR CAR FOR THE PARIS AND ORLEANS RAILWAY, FRANCE.

Steam drum, length	4 ft. 6 ins.
Heating surface	264 sq. ft.
Superheating surface	80 sq. ft.
Grate area	10¾ sq. ft.
Boiler pressure	600 lbs.
Height, rail to floor	4 ft. 0 in.
Height, rail to top of smokestack	13 ft. 8 ins.

From a horizontal header at one side, extend a number of approximately horizontal coils of pipe, ending in an upper steam drum. Larger vertical pipes connect the header with the drum. There are 41 of these coils or "serpentines," of 1¼ ins. outside diameter; 29 of these are vaporizers and 12 are superheaters. The two water tanks are connected by pipes and contain a supply sufficient for 30 miles; the coke box also contains a similar supply. The feed-water is supplied to the boiler by two small Blake duplex pumps. The Westinghouse air brake is applied to all the truck wheels and to the trailing wheels, and there is a hand brake on the truck. Sand boxes are provided on the truck.

The car has a large baggage compartment next the engine, and six passenger compartments; the three rear compartments are for 30 second-class and the others for 25 first-class passengers. Each has two transverse seats, except that the compartment next to the baggage compartment has but one seat. The roof has a low railing to enable large packages to be carried. A small door in the end partition allows access between the cab and the baggage compartment, and two swinging doors give access to a door in the boiler casing for cleaning the outside of the tubes.

A PARTIAL LIST OF RIVETED STEEL PIPE LINES in the United States was included in a recent special report made by Major Cassius E. Gillette, Chief of the Philadelphia Bureau of Filtration, as follows:

Year.	Location.	Size, ins.	Length, approx. ft.
1871	First Pittsburg, Pa., Rising Main	50	2,900
1891	East Jersey Water Co.	48	116,000
1891	East Jersey Water Co., Belleville	36	26,000
1892	Syracuse, N. Y.	54	6,500
1893	(2) Rochester, N. Y.	38	142,000
1894	Second Pittsburg, Rising Main	50	1,600
1894	Portland, Ore.	33 and 42	126,000
1895	Allegheny City, Pa.	60	50,000
1895	East Jersey Water Co., Kearney, N. J.	42	8,800
1896	East Jersey Water Co., Newark, N. J.	48	26,400
1896	East Jersey Water Co.	42	89,700
1896	New Bedford, Mass.	48	42,500
1896	Duluth, Minn.	42	15,000
1896	Ogden, Utah	72	5,000
1897	Minneapolis, Minn.	50	34,400
1897	Passaic Water Co., N. J.	42	21,000
1898	Albany, N. Y.	48	8,000
1899	Seattle, Wash.	42	32,400
1899	East Jersey Water Co.	51	47,500
1900	Utica Power Co., Utica, N. Y.	84	1,000
1899	Third Rising Main, Pittsburg, Pa.	48	4,400
1901	Atlantic City, N. J.	30	27,000
1901	Pittsburg, Pa., Supply Main	42 and 51	26,000
1902	Jersey City, N. J.	72	93,000
1902	Boston, Mass.	..	.....
1903	Newark, N. J.	60	39,300
1903	Troy, N. Y.	33	35,300
1904	Schenectady, N. Y.	36	23,000
1905	Lynchburg, Va.	30	12,000
1905	Wilmington, Del.	43	8,000
1905	Wilmington, Del.	48	12,000
1905	Passaic Water Co.	42	8,000
1905	Passaic Water Co.	48	2,000
1905-6	Pittsburg, Pa.	50	26,500
1905-6	Pittsburg, Pa.	36	4,100
1905-6	Pittsburg, Pa.	24 and 96	11,800
1905	Pittsburg, Pa.	30	2,600

It is understood that nearly twenty miles of large steel pipe will be laid by the city of Philadelphia, under Major Gillette's direction, effecting a large saving over either cast-iron or steel pipe under recently cancelled contracts. Some of the new steel pipe will be of the locking-bar type and the remainder will be riveted.

REINFORCED CONCRETE IN THE NEW SAN FRANCISCO BUILDING LAW.

The new building law for San Francisco has been completed by the committee appointed to draft it, and has been passed by the Board of Supervisors. Stated briefly, the old law has been entirely revised except that the so-called fire lines have been left as formerly, and that the clauses relating to frame construction are unchanged. The revision, while extensive, has been a task of improving details rather than one of making radical changes. All the old types of building construction are retained, even the Class C buildings (with brick walls and wooden interiors), being included, although this form of building constituted the major portion of the old city and was the one which suffered most from the earthquake and then spread the fire. We are informed that it was the intention of the committee to exclude this class of building from certain portions of the city, but the objections to this were too great to be overcome. In respect to Class A buildings, that is, buildings with steel frames supporting the floors and wall loads, the most radical changes are the clauses limiting the height of all such buildings to 1½ times the width of the street, and those providing for the use of reinforced concrete in walls, partitions, etc., as well as in floors. In Class B buildings, that is, buildings with self-supporting walls and metal frames carrying the floors only, the most radical change is the provision for the use of reinforced concrete for any or all parts of the structure. This portion of the new law is given in the following paragraphs:

REINFORCED CONCRETE FRAME.—Buildings of Class B may be constructed with a frame of columns, girders, beams, walls and floors of reinforced concrete.

REINFORCED CONCRETE.—All reinforced concrete shall be constructed in accordance with the following provisions:

The term, "reinforced concrete," as used in this ordinance, shall be understood to mean an approved concrete mixture reinforced by steel of any shape, so combined that the steel will take up the tensional strain and assist in the resistance to shear.

STRESS.—Reinforced concrete construction shall be of such nature that the stresses can be calculated according to the accepted formulas of modern concrete engineering practice.

CONCRETE—MIXING OF; METHOD OF TESTING.—The concrete shall be mixed in the proportions of not less than one of cement to six of aggregates, consisting of sand and gravel or broken stone of 1 in. major dimensions. The proportions shall be such that the resistance of the concrete to crushing shall not be less than 2,000 lbs. per sq. in. after hardening for 28 days. The tests to determine this value shall be made by a competent engineer under the direction of the Board of Public Works. The concrete used in reinforced concrete construction shall be what is usually known as a wet mixture.

STEEL.—All steel with an elastic limit exceeding 40,000 lbs. shall have a mechanical bond with the concrete.

REINFORCING—METHOD OF.—All reinforcing steel shall be completely enclosed by the concrete, and such steel shall be nowhere nearer to the surface than 1½ times the diameter of such reinforcing steel bar or rod or other shape, but never less than 1 in. The steel in beams or girders shall be so disposed that there shall be not less than 1½ times the thickness of the steel in concrete between the steel, and where the number of bars used cannot be placed in one plane they shall be placed in two or more planes.

Reinforced concrete shall be so designed that the stresses in concrete and the steel shall not exceed the following limits: Extreme fiber stress on concrete in compression, 500 lbs. per sq. in.; shearing stress in concrete, 75 lbs. per sq. in.; concrete in direct compression, 450 lbs. per sq. in.; concrete in spirally wound columns, 700 lbs. per sq. in.; tensile stress in steel, one-third of the elastic limit; shearing stress in steel, 10,000 lbs. per sq. in.

The adhesion of concrete to steel shall be assumed to be 75 lbs. per sq. in. of surface where bars are ¾ in. or less in diameter, and proportionately less in bars of a diameter greater than ¾ in.

The ratio of the moduli of elasticity of concrete and steel shall be taken as 1 to 15.

The following assumption shall guide in the determination of the bending moments due to external forces: Beams and girders shall be considered as simply supported at the end, no allowance being made for continuous construction over supports. Floor plates, when constructed continuous and when provided with reinforcement at the top of plate over the supports, may be treated as continuous beams, the bending moment for uniformly distributed loads being taken as not less than W L divided by 12; the bending moment may be taken at W L divided by 20 in the case of square floor plates which are reinforced in both directions and supported on all sides. The floor plate to the extent of not more than five times its depth may be taken as part of that beam or girder in computing its moment of resistance, and the beam and slab must be built at the same time as a unit.

W—The total load.

L—The distance between centers of support.

The moment of resistance of any reinforced concrete construction under transverse loads shall be determined by formulas based on the following assumptions:

(a) The bond between the concrete and steel is sufficient to make the two materials act together as a homogeneous solid.

(b) The strain in any fiber is directly proportionate to the distance of that fiber from the neutral axis.

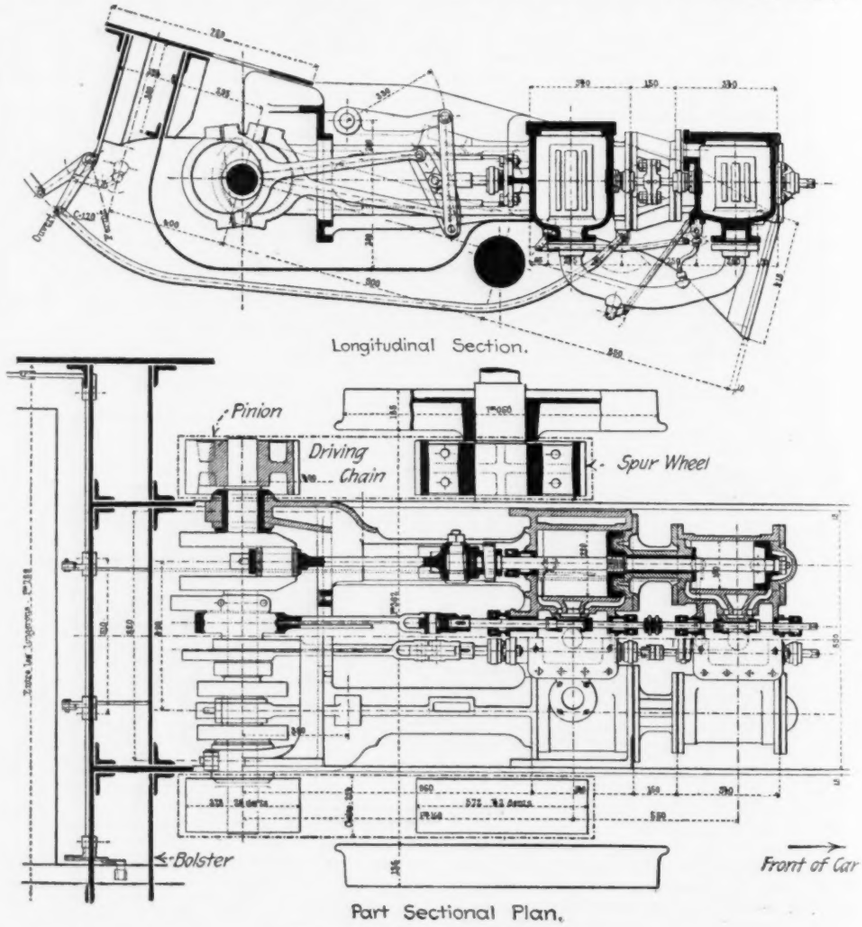


FIG. 2. ENGINES OF STEAM CAR.

(c) The modulus of elasticity of the concrete remains constant within the limits of the working stresses fixed in this ordinance.

The dimensions of such a beam or girder and its reinforcement shall be determined and fixed in such a way that the strength of the metal in tension shall measure the strength of the beam or girder. If the concrete in compression, including the allowable concrete in adjoining floor construction, does not afford sufficient strength for that purpose, the compression side of the beam or girder in question shall also be reinforced with metal.

All beams or girders shall be reinforced with metal if necessary for shear. Other reactions, if necessary, shall likewise be reinforced.

Neither the reinforcing metal nor the concrete shall be subjected to combined stresses so as to exceed in combination the stresses allowable separately.

Wherever possible, beams and girders, and also their intermediate floor construction, shall be made continuous. Reinforcing metal shall be used for that purpose in the top of all connecting members at the point of support, and it shall be sufficient both in section and length to prevent fracture at the point of support when the connecting members are carrying twice their calculated loads.

The reinforcing metal in the bottom of a floor may be deflected to the top of the slab along the line of support, or separate reinforcing material may be used for the reinforcement in the top of the slab. In either case, however, if a part of the slab is considered as part of the beam or girder, the reinforcing material in the slab must cross the full width both of the beam or girder and the part of slab so considered.

The centering for the beams and girders of a floor shall be constructed in conjunction with the centering for the floor slabs which they support, and no centering shall be removed until all parts of the finished floors are strong enough to support themselves and the loads that may come upon them during construction.

SHEAR: REINFORCED CONCRETE.—Reinforced concrete construction shall be designed so that the shearing stresses, both vertical and horizontal, developed in any part of the construction, shall not exceed the safe working strength of the concrete as fixed in this ordinance, or a sufficient amount of steel shall be introduced

The concrete shall cover the reinforcing bars at all points at least 1½ ins., and in calculating the strength of a reinforced concrete column this outside 1 in. of concrete shall not be counted as a part of the section of a column.

When the safe limit of adhesion between the concrete and steel is exceeded, some provision shall be made for transmitting the strength of the steel to the concrete.

COLUMNS: REINFORCED CONCRETE.—Reinforced concrete may be used for columns when the ratio of length to least side or diameter does not exceed 15. The reinforcing rods shall be tied together at intervals of not more than the least side or diameter of the column, or spirally wound steel may be used. No column shall be built less than 10 ins. diameter.

When vertical reinforcement is used in columns, such as rods, they shall have full perfect bearings at each joint, and such joints shall occur only at floors or other points of lateral support, and a tight fitting sleeve shall be provided at all joints of vertical reinforcing rods.

The axes of several columns acting continuously through two or more stories shall accurately coincide, and the constructor shall make special provision to effect this result.

WIND PRESSURE.—In the case of buildings in which allowances must be made for wind pressure, as provided in this ordinance, the reinforcing rods of columns shall be connected by threading the rods and by threaded sleeve nuts, or threaded turnbuckles, or methods equally effective and satisfactory to the Board of Public Works.

TESTS.—The contractor shall be prepared to make load tests on any portion of a reinforced concrete structure within a reasonable time after erection, as may be required by the Inspector of Buildings. Such tests shall show that the construction will sustain a load of twice that for which it is designed, without any sign of failure, or, in the case of beams, girders or floors, without deflecting more than one seven-hundredth of a span.

REINFORCED CONCRETE WALLS.—Buildings of Classes A and B having a complete skeleton construction of steel or of reinforced concrete construction, or a combination of both, designed to safely resist all of the strains caused by the dead weights of the structure and of the live loads and of the wind pressure within the safe limits of stress provided in this ordinance for each material used, may have reinforced concrete walls as specified.

Reinforced concrete walls shall be at least 6 ins. thick. If the area of wall surface included between any two adjacent wall columns and adjacent floor girders exceeds 300 sq. ft. and is less than 400 sq. ft., the thickness of the wall shall not be less than 8 ins. If such area exceeds 400 sq. ft. the wall thickness shall not be less than 12 ins., supported on the steel frame at each story. If the concrete be not reinforced the minimum thickness of walls shall be 12 ins.

In reinforced concrete walls the area of steel reinforcement shall aggregate 1% of the area of the concrete, one-half of which shall be placed vertically and one-half placed horizontally. No reinforcement shall be spaced more than 12 ins. apart. Additional reinforcement shall be placed around openings, and all reinforcement shall be wired at each intersection. All reinforcement shall be rigidly connected at columns and girders to the steel frame.

FADS AND FALLACIES IN HOT-AIR HEATING.*

By R. S. Thompson.†

That I may not seem to claim all wisdom in this matter, I ask you to interpolate the words "it is my opinion" before each of my statements. These are my "opinions" based on study, observation and experience.

It is a fallacy to suppose that a set of rules can be formulated by the observance of which any man can heat any building. In no two buildings will exactly the same conditions be found. Each building is a proposition in itself. Without an intelligent comprehension of the principles involved, an ability to closely examine conditions, ascertain causes, reason from effect to cause and from cause to remedy, a set of rules may be more of a hindrance than a help. There is no profession in which "a little learning" is more often "a dangerous thing."

Something over a year ago I was called to examine a large church, the heating of which had been a perplexing problem for more than a generation. The auditorium was always cold for at least two or three feet above the floor. I noticed that even when the church had been long heated there seemed to be downward currents of cold air. There was unanimity of opinion that something must be done to draw the cold air off the floor. One party had suggested putting in an electric fan and pumping it out. At one time the plan had been tried of cutting off the bottoms of the doors into the vestibule and leaving open the door from the vestibule into the tower. The draft of the tower had caused a strong outward flow of cold air under the doors, but the congregation complained so bitterly of cold feet that the plan was abandoned.

After learning all I could about the plans which had failed, I proceeded to diagnose the case. I had all three furnaces fired to the limit for three hours, and then sought carefully for evidences of "back pressure." I found none. Instead I found at the bottom of every door and window a strong inward current of air. That explained the situation. The building was leaking at the top—leaking so badly that all the air the furnaces could supply was being lost by leakage, and more was being drawn in from outside, which, being cold, of course settled on the floor. Had I followed the rule "draw the cold air off the floor" (which is the correct rule when a room is "air-bound" and there is "back pressure" on the furnaces), I would simply have drawn in more cold air to settle on the floor. This explained the failure of the plan to use the tower as a pump. This explained the downward currents of cold air. As the leaks could not be stopped, the only remedy was to pour in hot air faster than it could leak out at the top, and so "push" the cold air off the floor.

I examined the furnaces and found that when working up to the limit the three could deliver about 1,400 cu. ft. of air per minute. I took out two of them and put in two others with a combined capacity of 4,000 cu. ft. per minute, putting in larger pipes to allow for this larger flow. With these two going I again examined the building and found air flowing out gently under all the outer doors, but not enough "back pressure" to interfere with the operation of the furnaces. The congregation have not had cold feet since.

It is a fallacy to suppose that you can determine the amount of heat needed for a room or building by ascertaining its cubical contents. Heat once put into a building would remain there for ever, and a building once heated would require no further heat to maintain the temperature were it not for leakage of hot air out and leakage of cold air in and conduction of heat through the walls. But leakage and conduction both depend entirely on wall surface, and not at all on cubic contents, so that wall surface is the only thing to be considered.

I have adopted a rough and ready rule which works well in most cases with the average house, but which, like all other rules, must be used with common sense. "Divide the number of square feet of exposed wall surface by 2. The product is the number of cubic feet of air at 140° F. that will be required per minute to maintain a temperature of 70° F. with the outside temperature at zero." Of course it is up to the engineer to determine how many cubic feet of air at 140° F. any given furnace can supply, and how many cubic feet per minute each pipe can deliver. Rough and ready rules will not do in this estimate; an 8-in. pipe will deliver more air under some conditions than a 12-in. pipe under other conditions.

It is a fad to cover hot-air pipes with a thin sheet of asbestos paper, in order to "keep in the heat." The rough surface of the paper is a better radiator than the bright surface of tin or galvanized iron, and this more than balances the slight gain from the non-conducting power of the sheet of paper. Being spongy, it retains moisture and rots the pipes. The only good purpose I have ever known it to serve is to hide bad joints and botch work. If you must use asbestos, put on half an inch.

It is a fad to set the furnace under the northwest corner of the house with the idea that the air will travel through the pipes more readily in the direction the wind is blowing. Air, while in the pipes, does not know and does not care which way the wind is blowing. Set the furnace where you can reach all the rooms with the shortest pipes and the fewest angles.

It is a fallacy to suppose that you must put a register in the coldest part of the room in order to heat it. It is no warmer six inches away from the current of air that flows from a register than in any other part of a room. The air issuing from a register goes directly to the top of the room, and all heating with hot air is from above downward, no matter where the registers are placed. I should like to try the experiment of heating a house with all the registers in the ceilings. It would at least be a novelty, and I believe would have many advantages. It is a fallacy to put a register near an outside door or window in order that the wind which blows in through the cracks may drive the hot air over to the back part of the room. If the furnace is working properly there will be an outflow instead of an inflow of air around doors and windows. If the hot air enters near these leaks it will flow out through them and the cold air will be pocketed in the back part of the room. Put your register as far away from the outlet as you can and the hot air in making its way to the outlet will force the cold air out first.

It is a fallacy for a man to suppose that he can wait till his house is nearly finished before he places his furnace contract and then get good results. The furnace contract should be let before the excavation for the foundation is begun. As soon as the contract is let the engineer should take the blue prints or tracings of them and lay off on them the entire plan. The location of the furnace, the smoke pipe, the leader pipes from furnace to first floor register boxes and stack foot-pieces, the stacks, floor-runs, if any, and second flower registers should all be shown. The size of every pipe, stack and register should be given. Then these plans should be gone over with the owner to see that the location of the registers does not interfere with his plans for arrangement of furniture. This settled, copies of these plans should be given to the building contractor with instruc-

*Extracts from a paper read at the summer meeting of the American Society of Heating and Ventilating Engineers.

†Engineer, Springfield Heating & Ventilating Co., Springfield, Ohio.

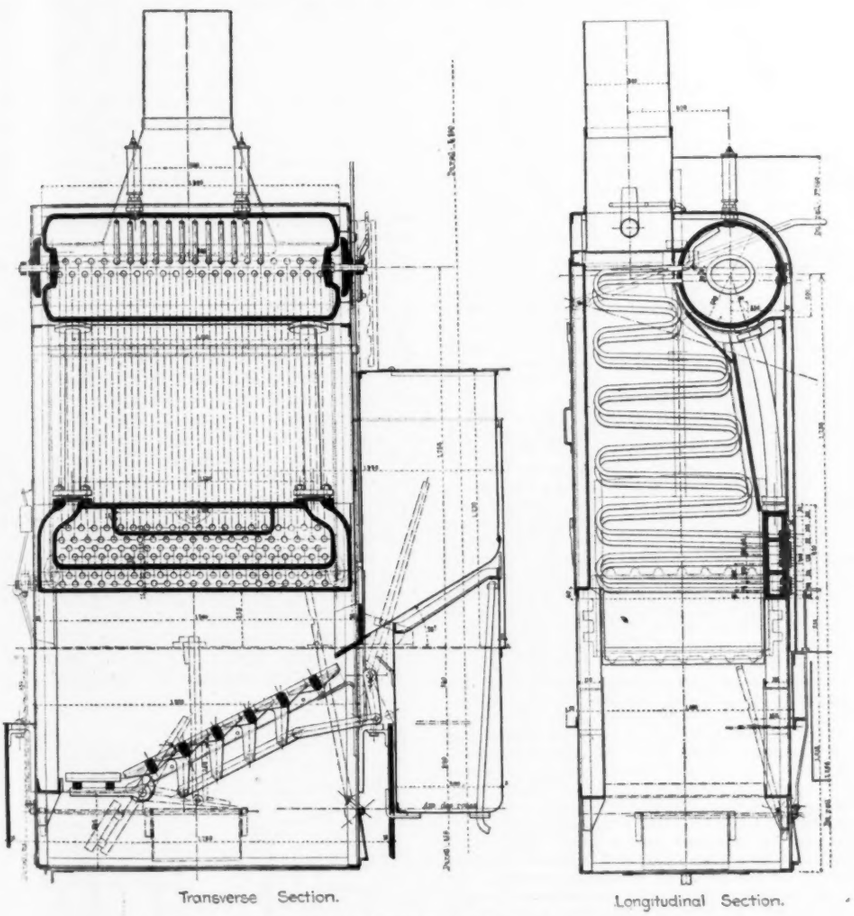


FIG. 3. PURREY WATER-TUBE BOILER FOR STEAM CAR.

tions that as the building progresses openings for pipes are to be left as shown on plans, and that plumbers, electricians and other contractors are not to use these openings nor obstruct the access thereto. The first clause in the furnace contract should provide that the building contractor is to observe the specifications and plans of the heating engineer the same as he does the specifications and plans of the architect.

It is a fallacy for a man to suppose he can give the building contractor the contract for putting in the wall stacks and registers, and then at any time have a "furnace-man" put in a furnace that will heat the house. When I am called on to put a furnace in a house where the pipes were put in by the building contractor I always agree to guarantee those rooms with which I make connections, but tell the party he must go to his building contractor for a guarantee on the rooms for which he put in the pipes. It is a fallacy to suppose that you can put in a furnace on plans provided by the average architect and afford to guarantee the job. The shoemaker should stick to his last and the architect should stick to his architecture. Not one architect in a hundred has a thorough theoretical knowledge of heating and ventilation, and probably less than one in a thousand has any practical knowledge on the subject. Both theoretical and practical knowledge are needed to secure a successful job. When I am brought a plan on which the architect has laid out the heating work, and asked to follow his plans and specifications, I tell the party that he must go to the architect for a guarantee on the results of the architect's work. It is a fallacy for a man to suppose that he can have his architect advertise for bids on a heating plant and let the contract to the lowest bidder and have a properly heated house. Where this is done the man who gets the contract is the one who has based his estimate on the smallest furnace, the smallest pipes, the cheapest material and the poorest job. When a test is made he sends an expert fireman, who stands over the furnace with a poker and makes it come near enough to fulfilling the guarantee so that the purchaser thinks it better to pay than have a lawsuit. And from that time on the purchaser has troubles of his own. And he tells all his friends and neighbors that if they ever build they should put in steam or hot water. Hot air is a failure; he knows, for he has a hot-air furnace in his own house.

It is a fad for people in furnace-heated houses to open windows in order to get fresh air. People have an idea that air is not pure unless it is cold, and that unless they can feel a cold draft on the back of their necks they are not getting ventilation. A house heated by hot air needs no ventilation but what the furnace gives it. If the house is too warm cut down the fire.

It is a fad to talk about furnace heat as a "dry heat." Heat not being a substance is never either wet or dry. Air when heated becomes "drier," that is its capacity to absorb moisture is increased. But it is the heating of the air that makes it drier and not the method by which it is heated. It makes no difference in this respect whether the air is heated by contact with the iron in a furnace, or the iron in a radiator, or the iron of a stove. If people want moist air make provision for moistening it, but I always wonder why the wise physicians who talk about the injury to the lungs from the "dry air of furnace-heated houses" send their patients with lung trouble to recover in "the pure dry air of Colorado and Arizona."

It is a fallacy to suppose that if a furnace heats a house it is necessarily a good furnace, and if it does not it is necessarily a bad furnace. Given two furnaces which can each deliver at the casing top the same number of cubic feet of air per minute, at the same temperature, one may be a good furnace and the other a bad one, but one will heat a house as well as the other. They may differ in fuel consumption, in cleanliness, in case of management, in durability and in many other points, but in the ability to heat the house there will be no difference. A furnace is a machine for the manufacture of hot air. That is all it is made to do and all it can do. The problem of manufacturing this hot air with the least expenditure of fuel, the problem of producing a machine for the manufacture of hot air which shall be cleanly, easy of management and durable are problems for the furnace manufacturer. But the problem of getting this hot air equally distributed through the various rooms of a house, and so, properly heating the house, is a problem that rests solely with the heating and ventilating engineer. Given a furnace, good or bad, which can produce the requisite quantity of hot air at the requisite temperature and the proper heating of the house depends wholly on the hot-air pipes and ventilating arrangements. The poorest furnace ever built, if large enough to furnish the requisite quantity of hot air, will heat any house if the engineering work is properly done. The best furnace ever built will not heat two rooms if the engineering work has not been properly done. This accounts for the fact that you will often find two men, using the same make of furnace, one of whom will declare it is the best in the world and the other is equally sure it is the worst. One is giving the furnace credit that belongs to the engineer; the other is placing on it blame which is due to the engineer.

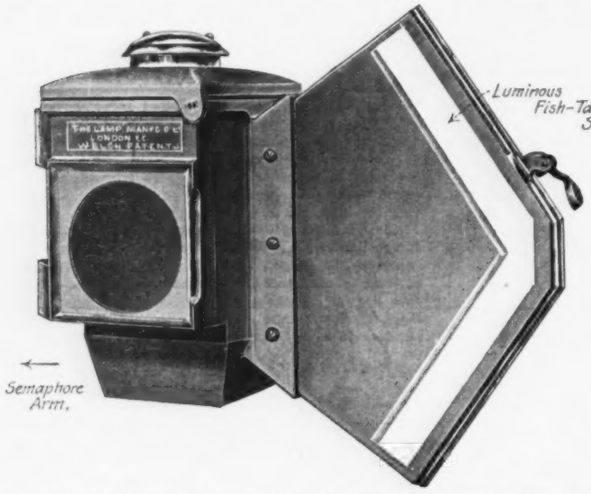


FIG. 1. ILLUMINATED FISH-TAIL TO INDICATE DISTANT SIGNALS AT NIGHT.

It is a fallacy to suppose that leader pipes in the basement must have an inclination or "pitch" of one inch to the foot in order that the hot air may flow through them. The "ascensional" force of hot air (if I may be allowed to coin a word) depends on the difference in elevation between the starting point and point of delivery. It will make no difference whether the air is carried 6 ft. perpendicularly and 12 ft. horizontally, or 5 ft. perpendicularly and 12 ft. at an inclination of one inch to the foot. What you gain in the pitch you lose in the riser. If I had to take my pipes off the side of the casing I would carry the casing up to within a few inches of the joists and carry the pipes horizontally under the joists. I would get the same total elevation by this plan as with a low casing and pipes inclined, but the elevation in the casing would be more efficient than in the pipes, because freer from friction. In practice I always use a flat-topped casing and take the pipes off the top because in this way I can make straight lines from furnace to register boxes and foot-pieces, something it is rarely possible to do where you take your pipes from the side of the casing. By running the leader pipes horizontally and close to the joists you leave plenty of head room in the cellar, if it is of reasonable depth.

But my time and your patience would fail should I attempt to give all the fads and fallacies which in my opinion have been connected with hot-air heating. The business has been far too largely left to unscientific men. Every man who has ever lived in a furnace-heated house thinks he knows all about heating with hot air. Every man who can handle a hammer and pair of snips thinks he is competent to put in a furnace. The popular impression has been that science and skill were not needed, and if the house were not heated it was the fault of the furnace or the system. We are as yet but in the infancy of the business. Sufficient data has not yet been obtained to reduce it to an exact science. In fact, as yet it can hardly be called a science at all. It is not strange that many believe that cheapness in first cost is the only thing the hot-air system has to commend it, and that cheapness in first cost is the only thing to be considered in having a hot-air plant installed.

THE STREET RAILWAY TRACK CONSTRUCTION of the International Ry., at Buffalo, N. Y., under recently adopted standards, consists of 9-in. 94-lb. grooved girder rails laid on a 6-in. bed of concrete about 7 ft. wide. At intervals of 5 ft. the rails are connected by flat tie bars having threaded ends which pass through the webs of the rails and are secured by nuts. Steel ties of the Carnegie pattern, of 6-in. I-beam section (Engineering News, Aug. 24, 1905,) are laid at intervals of 10 ft., trenches being cut to give a depth of 6 ins. of concrete beneath the ties; these ties are 6 ft. long, and each rail is secured by two bolted clamps. Gravel is laid upon the concrete to support the stone paving blocks which are used between the rails and tracks, while a line of stone blocks is laid between each outer rail and the asphalt paving of the side of the street.

TWO ENGLISH IMPROVEMENTS IN SIGNAL LAMPS.

The advisability of giving a distinctive distant signal by night as well as by day has been frequently discussed, and the tendency in this country is to use a yellow light for this signal. Some English railways are now experimenting with the Coligny-Welch lamp for distant signals, in which an extension projecting from the lamp case has an illuminated slot of fish-tail pattern, corresponding to the fish-tail on the semaphore arm. This is illuminated from the ordinary signal lamp by a reflector, no additional light being required. It is stated that the luminous white fish-tail can be clearly seen at a distance of 750 ft., so that an engineman can tell whether a red light means "stop" or "prepare to stop." The slot is white, whether the spectacle shows red or green. This device is shown in Fig. 1, and the fish-tail extension is on the opposite side of the post from the semaphore arm.

Another English improvement is the Welch long-burning oil signal lamp, which requires no chimney. It will burn continuously (day and night) for from 10 to 14 days without attention, although it is recommended that it should be filled and trimmed every week. The lamp burns American oil, which, it is said, will cost only about $1.50 per lamp per year (including waste), while with ordinary oil lamps the cost is from $2 to $3.50 for oil alone, exclusive of the daily expense for extinguishing, trimming and lighting lamps. With gas in signal lamps the cost is said to be from $10 to $15 per lamp per year. Thus, if the claims should be realized in actual practice it would be cheaper to use the new lamps and keep them burning continuously. The construction is shown in Fig. 2. The brass holder A is made to fit any oil cup, and has a central tube B, the upper part of which has a number of ⅛-in. holes. Through this tube is passed the main wick, C. An auxiliary wick, D, passes up through a hole beside the tube and is coiled loosely around the perforated part of the tube, but does not reach the flame; its purpose is to feed oil to the main wick. In tests reported in "The Engineer," of London, the lamps only actually burned out at the end of 13 days, although for the last two or three days the size of the flame was considerably diminished. As a rule there is a slight decrease in the illuminating power each day, but this is not sufficient to affect the efficiency of the lamp for from seven to nine days. In some exceptional and unexplained cases the brilliancy increased after a few days and maintained this condition for some time.

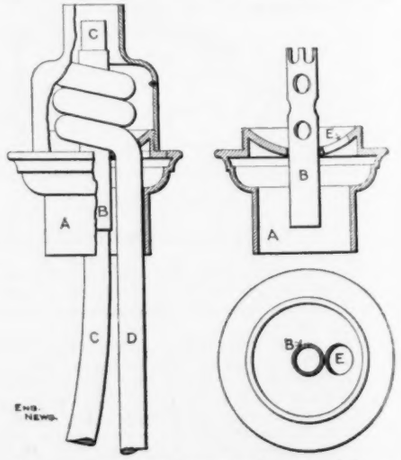


Fig. 2. Burner of Long-Burning Signal Lamp.

Both the distant-signal lamp and the long-burning lamp are among the specialties of the Lamp Manufacturing Co., 10 Leonard St., City Road, London, England.

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The cost of forms and molds amounts to such a large proportion of the total cost of reinforced concrete work that earnest endeavor to bring about its reduction deserves attention. For this reason, if for no other, we anticipate the interest of engineers in the new method of forming reinforced concrete piles, poles and columns without molds by a simple process of rolling or winding concrete and reinforcement on a permanent mandril, which is briefly described in another part of this issue. Reinforced concrete piles have always been constructed by depositing concrete around reinforcing bars or frames in wooden molds. In Europe the molds are commonly set on end, but this practice is not universal; in America the most common practice is to lay the mold horizontally on the ground. Indeed, we recall but one instance—the molding of 12-in. piles on end for the pier construction at Atlantic City, N. J., described elsewhere in this issue—in American work of piles molded endwise.

A comparison of these two methods of molding brings out several matters of interest. As nearly as it can be got at, the merit claimed by European practitioners for end molding is that any stratification that may result from tamping in layers or from segregation is in planes normal to the compressive stress due to load or to hammer blows on the pile. This fact, it is thought, tends to reduce shattering of the pile in driving, since the concrete will presumably not split nor spall off so readily as if the stratification were longitudinal, as is the case in horizontal molding. We are not aware whether proof of this reasoning has been demonstrated in actual work in Europe, but it certainly does not seem to have been indicated in any work done in this country. The bulk of reinforced concrete pile work has been done with horizontally molded piles, and, while the amount of hammer driven work is small compared with jet driven work, and is, moreover, of insignificant magnitude as compared with European reinforced concrete pile work, no failures have been recorded as definitely attributable to this fact. Possibly the reason for this may be that in the generality of European work a rather dry mixture is used which has to be tamped into place, while in America a very wet mixture is used which can be poured and puddled into place without tamping, as that process is commonly understood. Be this as it may, American experience does not support the idea that there is any particular practical advantage in molding piles or any other compression member vertically. On the contrary, there seem to be some very sound economical reasons for molding them horizontally whenever it can be done.

When the molds are set on end they must be supported in their upright position by staging, which involves expense for materials, erection and removal; further, end molding means generally that the concrete materials or mixture must be elevated to the tops of the molds, and, finally, if end molding is resorted to more lumber is required for the molds proper. Horizontal molding obviates the necessity of stagings and of elevating the material, and it materially reduces the expense of forms. A square pile can be molded horizontally, for example, in a three-sided form, which means at once a 25% saving in material and the doing away with yokes, clamps and bolting in a large measure. Furthermore, in horizontal molding the side pieces of the form can ordinarily be removed in 24 to 48 hours and used again for another pile; the bottom boards only require to be left in place until hardening has reached such a stage that the handling of the pile is safe. Evidently the saving in material is less if round or polygonal piles are being made, but even here it cuts a material figure. To summarize briefly, therefore, horizontal molding is decidedly cheaper than vertical molding for piles, and, so far as the evidence at hand goes, does not result in a sensibly inferior pile.

Reduced to its lowest, however, the cost of forms for molding piles is an important item in their manufacture. The cost increases, moreover, as the length of the pile is increased because of the difficulty of maintaining and supporting the long forms in alinement. Warping is exceedingly difficult to prevent in molds that reach lengths of 50 ft., and a mold can seldom be used more than a few times before this distortion has rendered it useless. In its attempt, therefore, to do away with forms in molding piles the method of construction by rolling presents important possible advantages.

Apropos of our comments last week on the widely published statements regarding the demand for students graduating from the engineering schools this year, we notice in "Mines and Minerals," for July, a letter from an officer of a mining company at Butte, Mont., indicating that instead of seeking college graduates, his company has many applications from technical graduates seeking employment as ordinary miners. We print the letter as follows:

Editor of "Mines and Minerals":

Sir: During the last three months our company has received numerous applications for positions from young men about to graduate from technical institutions. The answer forwarded to each has been the same—no opening for young men who want to learn mining practically; our company is not in the educational business. I find by inquiry among other mine managers that their experience has been similar to mine, so I wish to write you our point of view with the idea of starting a discussion that may be of benefit to us all, especially to the young fellows just starting out. Let me state at the outset that during the last 10 years up to two years ago, our company annually employed at least one, and sometimes two, college graduates, and started them in at $3 a day.

They were put in the mine at mucking, or mining, if they showed ability, and later given a chance about the cyanide mill. Now any one that has tried it will know that for the first year a college man does not fairly earn $3 a day working as a laborer, no matter how hard he works. He simply has not the knack of handling tools, nor is his muscular development as good as that of the average miner who has been used to heavy work from his youth up. But our company went on the assumption that a man's engineering knowledge is of no practical use to him unless he has first had experience in practical mining, and was willing to pay him for undergoing that experience in order to get the benefit of it when he was promoted to engineering later on. But unfortunately about the time when our young men were beginning to actually earn what they were paid, they would suddenly consider themselves experienced engineers and leave us on short notice with the remark that they had got the experience they were looking for. That is why our company has come to look upon the training of college men about our property as unprofitable, and has concluded to go out of the educational business.

Possibly the trouble in many cases has been the fault of daily association with ordinary miners, who, as any Western man knows, are apt to be of the wandering kind who rarely stay more than six months at one mine. These fellows are good miners, but better dreamers sometimes. They always imagine that a new camp will give them a better chance at sudden fortune, or maybe its just a plain case of better grub wanted. The college man makes a great mistake who allows himself to become inoculated with the wandering fever. In the first place he is not a good miner, and if he succeeds in getting a job at another mine he will likely find that he was engaged with no idea of looking out for his future, and he is apt to "get his time" when a better miner comes along. I have been speaking altogether of the majority of graduates who have, to start their career as miners, muckers and roustabouts. Of course, a small proportion of the total number are fortunate enough to be able to start as assayers or assistants on the surveying corps, or in rare cases as managers of small mines. But my idea of the whole case is that unless a young fellow gets a chance at some such opportunity he will do better to stick at the rough work till he does and remain with the company where he started. Recently I met an engineer who told me that his advice to college men was to move about from place to place as rapidly as circumstances and their acquirement of experience would allow. Needless to say, we disagreed. But I have stated my view of the case, and now hope to see the other side, particularly from some of the graduates themselves who have had two or three years' experience.

L. R.

Butte, Mont.

Strictly speaking, "superheated" steam and "overheated" steam mean the same thing; but it looks queer, nevertheless, to read in one of our esteemed contemporaries in the railway field an article entitled "Experience with Overheated Steam Locomotives." This title well matches that of an editorial which recently appeared in another technical journal on "Denaturalized Alcohol."

THE NEW YORK BARGE CANAL: SHALL ITS CAPACITY BE ENLARGED?

Three years ago, when the proposal was under consideration to enlarge the Erie Canal so as to accommodate barges of 1,000-tons capacity, Engineering News, as many of our readers will recall, urged that this capacity was too limited, and that if it was worth while for the State of New York to spend a hundred million dollars to enlarge this waterway, it was worth while to spend the very little additional that would be required to make the waterway big enough to be of real commercial importance. We said at that time that the 1,000-ton barge canal was likely to be obsolete, as an economical freight route, before it was completed; or if not wholly obsolete, then so much less important than its projectors expected that the voters of the State would be grievously disappointed in their investment.

As our readers will also recall we never advocated a ship canal for ocean vessels from the seaboard to the Lakes. What we did favor was a canal large enough to permit through traffic to pass from the Lake ports to tidewater without breaking bulk. In this position we were supported by the highest authorities in the engineering profession, as shown by the letters published in this journal at the time.

It has recently been brought to our attention that the Advisory Board of Engineers, created to supervise the barge canal work, formally recommended some time ago an increase in the dimensions of the barge canal. This Advisory Board is made up of Messrs. Edward A. Bond, late State Engineer; W. A. Brackenridge, E. L. Corthell, Alfred Brooks Fry and Col. Thos. W. Symons. The action of this body of eminent engineers on this matter is recorded as follows in its annual report:

"After due consideration and full discussion of the matter of width of locks for the Barge Canal, submitted for consideration by a letter dated June 23, 1905, from the State Engineer, addressed to the chairman of the Advisory Board of Consulting Engineers for the Improvement of State Canals, said Board passed the following preamble and motion:

"Whereas, The general modern tendency in all countries, especially upon canalized rivers, is to increase the size of the channels, locks and boats; and

"Whereas, The Canadian system of canals from Lake Erie to Montreal has a depth of 14 ft. and locks 45 ft. wide, and the depth and locks of the proposed Montreal, Ottawa & Georgian Bay Canal will be as great; and

"Whereas, The proposed Lake Erie & Ohio Canal, between Lake Erie and the Ohio River will have a depth of 15 ft. and locks 45 ft. wide; and

"Whereas, The proposed navigation of the Illinois River and on the Mississippi River to St. Louis is to have a depth of 14 ft.; and

"Whereas, The advantages of standard dimensions of canals are appreciated by European countries, which are working toward uniformity in the dimensions of international canals and canalized rivers; and

"Whereas, It might be greatly to the advantage of barge owners to employ their barges in coastwise traffic in the winter months during which navigation is closed on the canals, and for which traffic steel model barges of proper width, length, draft and strength would be admirably adapted; and

"Whereas, Increase of depth in waterways importantly decreases the cost of transportation, not only by increasing the tonnage of vessels, but by reducing the tractive force required, by giving more space between the bottom of the boat and the bed of the channel; and

"Whereas, The commercial success of the barge canals of the state of New York in competition with other routes—water and rail—will depend largely upon their ability to transport freight at the lowest possible cost, obtained especially by having a waterway and boats of large dimensions; and

"Whereas, About 76% of the total length of the proposed waterways between New York City and Rouses' Point on Lake Champlain, Oswego and Buffalo, will be in open water of rivers, lakes and canalized rivers, and in the remaining 24% of the distance there is a considerable length where—in rock excavation and elsewhere—there will be, according to present plans, a sufficient width for two 43-ft. beam boats to safely pass, and much of the remaining excavation in earth may be conveniently widened any time in the future—and in some parts, where the new canal will occupy the present canal sections in embankment, it may be formed conveniently during construction by moving over one of the banks to the full width required to pass two 43-ft. beam barges, without materially increasing the cost—and the necessary deepening between 12 ft. and 14 ft. may be done in the future when the commerce requires it; and

"Whereas, This Board has ascertained from the State Engineer that the additional cost of building all the locks on the entire system of barge canals 328 ft. long (the present proposed length), 45 ft. wide and 14 ft. deep will not cause the total cost of the canal to exceed $101,000,000 provided by law, due to economies and reductions in costs in several directions over the original estimate on the basis of which the law was enacted; and

"Whereas, The State Engineer has informed this Board that the provision in the original plans for water for the use of the barge canals and for other purposes is ample to meet the additional amount required for the lockages in the larger locks now proposed; and

"Whereas, In order to provide a waterway of larger dimensions in the future, if desired, all permanent structures should be built and necessary provision made at the outset to meet such enlargement in order to avoid excessive future cost; therefore

"Resolved, That in the opinion of this Board the locks of the barge canals should be built of the following dimensions:

"Three hundred and twenty-eight feet clear length between hollow quoins, 45 ft. clear width, and 14 ft. depth over miter-sills."

The subject was then taken up by the Canal Board, which concurred in the opinion of the Advisory Board as to widening the locks, *but did not favor at this time their being deepened.**

The Board has recommended that the right-of-way be wide enough for future enlargement of canal sections, and in making plans has provided that spoil shall be so deposited that it will not have to be rehandled for the excavation if the canal is subsequently enlarged.

We appreciate, of course, that to a certain extent the State officials are bound by the actions already taken. The act of the legislature called for a canal of certain general dimensions and this act was approved by popular vote. That the dimensions then chosen were mistaken ones and that the canal as planned is not big enough to do all that was expected of it was clear at the time to expert students of the problem. It now appears, from the above printed resolutions, that this fact is now clear also to the Advisory Board of Engineers, charged with responsibility for the construction of the canal in a manner most advantageous to the State. To make the best of the blunder, the Advisory Board of Engineers now urges that the locks of the canal shall be widened to 45 ft. and deepened to 14 ft. in place of the 28 ft. and 12 ft. originally proposed. This would enable the barge canal to be used by vessels as large as those which now use the Canadian St. Lawrence canals and the Welland Canal, or with a capacity of approximately 2,200 tons, in place of the shallow 1,000 ton canal barges, for which the New York canal was first projected. Inasmuch as the estimates show that this widening and deepening of the locks can be effected without exceeding the $101,000,000 limit of cost, there would appear to be every reason for making this change of plan. It is stated, however, that the Canal Board, while it approved the widening of the locks, "did not favor at this time their being deepened."

*Italics ours.—Ed.

The layman reading this might fancy that the future deepening of the locks was a simple and trifling matter; but we need hardly say to the readers of Engineering News that to deepen the locks at some future day from 12 ft. to 14 ft. will involve little less than their entire reconstruction. In other words, the State officials are deliberately proceeding to spend the taxpayers' money on work which will have to be torn out and rebuilt within a few years if the canal is to be made really effective.

It may be of interest at this point to inquire who are the members of this Canal Board which has cast aside the recommendation of the Advisory Board of Engineers. We find that it is made up of the Lieutenant-Governor, Mr. M. Linn Bruce, of New York; the Secretary of State, Mr. John F. O'Brien, of West Chazy; the Comptroller, Mr. Otto Kelsey, of Geneseo, and the State Treasurer, Mr. John G. Wallenmeier, of Tonawanda. Of these gentlemen, Mr. O'Brien is a wholesale coal, flour and grain dealer, and Mr. Kelsey is a lawyer. The occupations of the other two members of the Canal Board are unknown to us; but there is no reason to believe that they are by training or experience qualified to compare as experts in economic transportation matters with such men as Mr. E. L. Corthell or Col. Thos. W. Symons of the Advisory Board.

So far as we are aware, the press of New York State has paid no attention to the matter and very probably is entirely ignorant concerning it. We feel it our duty, therefore, to bring the subject to public notice. The Advisory Board of Engineers was created by statute for the express purpose of seeing that the barge canal work was carried out in the best possible manner, and so as to secure the largest possible return for the taxpayers' money expended. Their recommendation to enlarge the locks of the canal was taken after full consideration and is far and away the most weighty and important matter that has come before the Board.

We believe the rejection of this recommendation by the Canal Board is a most serious mistake, one which means a loss of millions of dollars to the State; and that public opinion ought to be expressed through the press of the State in a way to cause the Canal Board to rescind its action and approve the proposed enlargement of locks.

LETTERS TO THE EDITOR.

A Method of Determining the Cross-Section and Pitch of Hooped Reinforcement for Concrete Columns.

Sir: In the design of reinforced concrete buildings several stories in height where floor space is valuable, it is important to keep the columns as small as is consistant with good design. The minimum sizes are obtained either by the use of large amounts of steel, which makes the column an expensive member, or by thoroughly hooping it, using a small amount of longitudinal steel and a high working load upon the concrete confined within the spiral. Everything considered, the latter seems to be the better method.

The following method for determining the cross-section and pitch of this hooping steel is taken from the work on reinforced concrete by Chas. F. Marsh, the arrangement of the formulas and assigned values being the writer's. It is offered as a suggestion to those who, like the writer, may have been at a loss for a satisfactory method for determining the required amount.

Assuming a safe working stress on the concrete core of 1,000 lbs. per sq. in., the hoop tension for each inch of height of the column is 32.5 d.

$$a = \frac{32.5dp}{s} \text{ and } p = \frac{sa}{32.5d}$$

where d = diameter of the core in inches,
a = the cross-section of the hoop,
p = the pitch, and
s = the allowed stress in the steel.

As the steel will be either band steel or wire, a high value may be used, say 20,000 lbs. per sq. in. The pitch should not exceed $\frac{d}{6}$. The column is now designed using 1,000 lbs. per sq. in. upon the concrete core and 10,000 lbs. per sq. in. upon the longitudinal steel.

Very truly yours,
F. F. Weld,
Engineer, Trussed Concrete Steel Co.
Detroit, Mich., July 5, 1906.

The Symbol for Expressing Inches and Feet on Drawings.

Mr. Geo. H. Follows:

Sir: I am very much interested in your [illegible]ersal drawing dictionary, in which you show some very deep work. I note in your article on "Dimensioning," in Engineering News of May 31, that you make use of two ticks (") to denote inches. I was [illegible] a prominent engineering concern in Philadelphia for [illegible]eral years, and its managers always objected to this method of indicating inches and feet as they had several serious mistakes happen from the inches being mistaken [illegible] feet where the ticks were overlooked.

On one occasion they ordered 100 pieces of sh[illegible]g 6 ins. in diameter and 13 ins. long and in a few da[illegible] were surprised to find a wagon load of 13-ft. shafting [illegible] their doors. It also proved quite expensive to me on [illegible] occasion, when we were getting out a number of [illegible]motive connecting rods, they were made several in[illegible] too long, because of an error in reading the feet and [illegible]hes.

Since then we have dropped the method, and mark "in." on any figures which are likely to be mista[illegible] for feet or likely to be wrongly read when inverted [illegible] for instance: 9 in., 6 in., 11 in., 16 in., 19 in., etc. When we wish to designate feet we mark ft. and in. On the whole it is evident that it is entirely unnecessary to mark the ticks after each figure when the scale of the drawing is given or when an over-all dimension is marked in feet and inches. We have also had trouble when using ticks on account of corrections; one tick would be erased and perhaps the draftsman would forget to put the other in. On the whole I believe that ticks in many places are superfluous and merely clutter up the drawing.

Very truly yours, Subscriber.

St. Marys, Ohio, June 6, 1906.

[The above letter was addressed in care of Engineering News and was forwarded to Mr. Follows, who returns it for publication with the following reply:—Ed.].

Sir: A few firms omit the inch marks altogether except for such numbers as can be read either side up. It always seemed to me, however, that this was begging the question, because it would not do to enforce such a rule rigidly; in many designations the inch mark is absolutely necessary.

In Fig. 5, Part III. of the "Dictionary" it is recommended that when a distance is to be expressed in feet and inches it should be done after the following manner: 6'—0", 3'—5½". Either 6'—0" or 6 ft. is good; but 6' is *incomplete* and should never be permitted.

After all, however, has not the exact use of the inch mark a comparatively small bearing upon drawing as a language, and upon the uniformity of drawings? Mistakes will happen in spite of any system; it is even possible, by mistake, to write "13 feet" instead of "13 inches." Do we not reach a point in any system when we must pin our faith to the man behind the gun? I have known draftsmen with whom the habit of not making mistakes was so strong that they never made any.

G. H. Follows.

Pittsburg, Pa., June 29, 1906.

Concerning the Journal of the Franklin Institute.

Sir: In looking over the July number of the "Journal of the Franklin Institute," I notice that the leading article is a paper on "The Terminal Lake Canal," by Mr. Lindon W. Bates. This paper is headed as follows:

THE FRANKLIN INSTITUTE.
(Stated Meeting, held Wednesday, Sept. 20, 1905.)

The reader would certainly infer from this that Mr. Bates' paper was presented, in some form, at a meeting of the Institute, held on Sept. 20 last. But the very first sentence of Mr. Bates' paper reads:

Much prominence has been given to the Minority Report of five members [of the Board of Consulting Engineers] dissenting from the sea-level proposition in favor of an 85-ft. canal.

The Report of the Board of Consulting Engineers was not made public until Feb. 19, and in September last the Board had barely begun its work. It is evident, therefore, that Mr. Bates' paper cannot have been presented at the meeting of Sept. 20, 1905. As it is chiefly a criticism of the canal plans presented by the Board, it must have been written since those plans were made public; and the reader is left in doubt whether the paper has ever been presented before the Institute at all.

This may seem to some a trifling or unimportant matter; but I cannot look at it in that way. Contributions to technical literature constitute to-day the engineering data on which the profession relies for guidance. The date when an article was written or made public before an engineering society of standing has often been the point on which important suits at law have hinged, as well as decisions as to priority in professional work.

Besides this the question may well be raised whether the "Franklin Institute Journal" is a record of the Transactions and papers presented to that society, or whether it is supposed to publish contributions like an ordinary technical journal. If the latter is the case, then such papers should be properly marked to distinguish them

from those actually read before the Institute or some of its Sections. I question, however, whether the Institute is justified in using its funds to carry on a publishing business beyond the scope of its Transactions. There is enough technical literature published nowadays, surely; and the engineer who has anything important to bring before the profession has channels enough open to him, without using the funds of engineering societies for that purpose. J. F. I.

Washington, D. C., July 14, 1906.

[Proof of the above letter was sent to the Secretary of the Franklin Institute and we append his reply, as follows.—Ed.]

Sir: The criticism of your correspondent is strictly correct. Mr. Bates presented a communication on "The Terminal Lake Canal" at a meeting of the Institute, held Sept. 20, 1905, but its publication was unfortunately delayed, on account of superabundance of material for publication, and when it finally appeared, certain additions to bring the subject up-to-date were made by the author; and the article appeared in its present form. The inconsistency of the additions in reference to dates did not attract the editor's attention at the time. A foot-note stating that the article was revised to date would have met your correspondent's criticism fully. However, it does not seem to me that the incident is of sufficient importance to claim attention. Yours truly,

Wm. H. Wahl, Secretary.

Philadelphia, July 18, 1906.

Concerning the Right of an Engineer to Have the Best Offer for His Services.

Sir: Noting the communications from "R" and "M" in your issues of June 21 and July 5, and your reply thereto on the above subject, I will say that it is the first time I have seen the facts as they really are, partially brought out in print. The same circumstances are happening every day, and that is what keeps the engineer down and works an injury to his employer. After an engineer has worked from three to five years for a company, he knows, or should know, as much about the business in his line as the superintendent, and naturally wants a compensation suitable to the position; but he does not get it, he feels dissatisfied, he loses all interest, sees no prospects, gets an offer of an advance from another company and begins over again. The salaries remain the same; the company loses an experienced man just when they want him.

I will give one case that came under my observation while working for a coal company. A neighboring company wished to build a railroad a few miles long. They had a full corps of engineers and asked one of the engineers who had had experience in railroad work to build the road, but they could not advance his wages. So they sent three hundred miles for a strange engineer, made him chief, and paid him three times the salary of their resident engineer. You can imagine the feelings of the man who had worked for them for years.

I was surprised to see as chief engineer a man I had known personally a few years previous, conducting a business entirely foreign from the profession. I asked him how he got the position, and when he learned the business. His answer was: "If you have the 'pull' it is not necessary to know much." I said nothing but watched developments. The company lost two experienced engineers and several thousand dollars in cost of construction rather than encourage a sub-engineer who knew just what they wanted and how to do it.

From my experience and the communications referred to above, I would judge that the majority of superintendents and chief engineers forget that they were once engineers—unless they got their position by a "pull," and if so they will find about as much human nature in one class of engineers as in the other, and some times more.

It seems to be a universal habit among chiefs and heads of departments of companies and corporations to consider the engineer as a handy-man, and not to be considered in a business proposition. It is the engineer who works out the plans for a successful operation; he will work for months and years, spending his time and money for an education and experience, and then have his plans changed or discarded by a man who does not know the first principles of the work to be accomplished—just because he is over the engineer—and at the same time costing the company thousands of dollars.

Engineering is the poorest paid profession in the land to-day. We cannot get along without the engineer, but if he should ask for a raise in salary or should get a better offer elsewhere, we combine to keep him down. I have always found it best to keep in touch with the engineer or professional man. Tell him what you want and why you want it; he will take an interest in the work and may suggest a new idea. If so, consider it; give him credit for it. If it does not suit you, tell him why; if it does suit you, pay him what he is worth and you will have a man that will make money for you instead of one that will help rob you. If your business does not allow you to pay what the man is worth, and he has a better offer, help him to get more if you can and he will help you to a good man. You cannot pay a good engineer too much, and you don't want a poor man at any price. Under the present administration the man who has the pull gets the money, while the man on the ground does the work. "C."

Virginia, July 10, 1906.

Notes and Queries.

A. K. R., Alameda, Cal., desires information as to practice in burning lime with crude oil as fuel.

A "Railroad Civil Engineer" is informed that anonymous letters cannot be published. The real name of the writer must be furnished us as a guarantee of good faith.

J. G. B., New York City writes:

Will you kindly assist me in obtaining, through your "Letters to the Editor" column, an expression of opinion as to what is a "close row" of piles?

In the article on "A Remarkably Good Record for Paint," which appeared in our issue of July 19, p. 70, the building undergoing repairs was stated, through a misunderstanding, to be the Lawyers' Title Insurance Co.'s Building, 37-39 Liberty St., New York City. The engineer in charge of the work informs us that the building was one in the next street, the Fahys Building, 54 Maiden Lane.

The following question, not very clearly put, is submitted by E. V. Guyther, of Culiacan, Sinaloa, Mexico:

"A" instructs "B" to run a 100-kilometer tangent, giving a course bearing S 60° 20' E, "A" having ascertained by observation that this course would cut the knob of a large mountain beyond end of tangent. The line is started from the top of a church with foresight on the mountain. After setting two points on the ground, the foresight is no longer visible, and the line is run through by backsights and foresights of ordinary length in railroad practice. When the tangent is carried through to the end in this manner and the foresight is again visible, will the crosshair of the transit cut the foresight, no correction having been made for curvature of the earth's surface?

The earth's surface curves vertically away from the line of sight in all directions (considering the earth as a true homogeneous sphere), and therefore if a line marked out on the ground be prolonged by transit, all stakes will be on a great circle, that is, they will lie in a plane which intersects the earth's surface at right angles at all points of the circumference. "A," in seeing the mountain, looked along a line of sight lying in the plane of the great circle subsequently staked out by "B," and if "B's" work were properly done and sufficiently accurate, his vertical wire should, at the end of the line, cut the mountain. Refraction effects would not alter the result except under the unusual circumstance of lateral refraction. The true azimuth of the line would change as the work progressed, but this would not affect the question at issue.

CONCRETE BLOCKS FOR LINING TUNNELS.

The Mexican Central Ry. has used concrete blocks for the roof lining of tunnels, being cheaper than cut stone. Fig. 1 shows a tunnel with this lining on the Tuxpan-Colima extension, and Fig. 2 shows the forms of the blocks. These blocks weighed about 108 lbs. each, so that one man could handle them and place them in the arch.

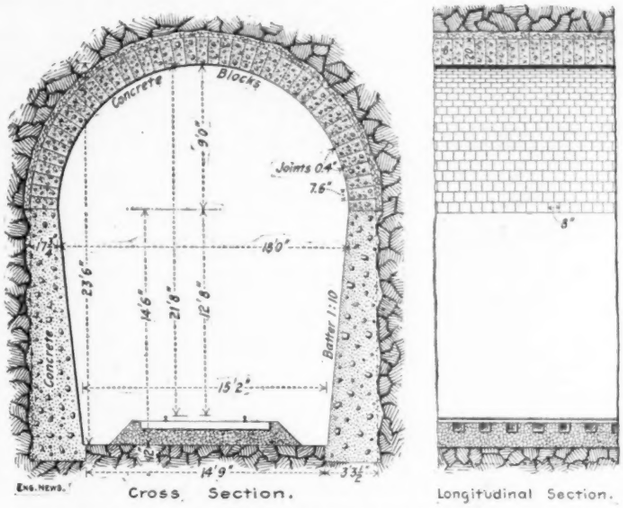


FIG. 1. TUNNEL WITH ROOF LINING OF CONCRETE BLOCKS; MEXICAN CENTRAL RY.

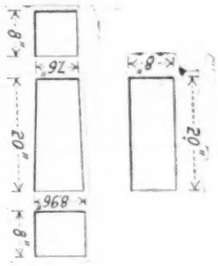


Fig. 2. Concrete Blocks for Tunnel Roof.

The same style of lining was also used for the roof of the Barrientos tunnel, which was completed a little more than two years ago, and whose construction was described in our issue of Aug. 10, 1905. This tunnel was excavated through a kind of porphyry or gneiss rock, full of blind seams. The blocks were formed of a mixture of 1 part of cement, 3 parts of sand, and 6 parts of stone broken to pass through a 1-in. ring. The blocks were made in wooden box molds, and tamped by hand, no machinery being used. They were laid by contract. This tunnel was built jointly by the Mexican Central Ry. and the Mexican National Ry., and the cost to the former was about $315,000 (Mexican currency). For blue prints and particulars of this work we are indebted to Mr. Lewis Kingman, M. Am. Soc. C. E., Chief Engineer of the Mexican Central Ry.

THE USE OF FEED-WATER HEATERS IN CONNECTION WITH HEATING SYSTEMS.*

While it is a fact that every 10° rise in the feed-water temperature corresponds to about 1% saving in fuel, this gain in economy is apparently frequently overlooked by manufacturers and owners. Feed-water heaters faulty in design or of insufficient capacity are installed; live steam is used where exhaust would do as well; condensation is allowed to go to waste which could easily be utilized; and heat units which should be saved are lost in other ways.

In certain kinds of manufacturing plants having many hot greasy drips from machines, this water is made to flow through the pipes of a horizontal heater as illustrated in Fig. 1, the boiler feed water filling the space between the tubes and the shell. Exhaust from pumps and other apparatus may be discharged through the same heater if desired.

The coldest feed water surrounds the lower pipes containing the least hot drips, so that they pass from the heater to the sewer at relatively low temperatures, having transferred most of their heat to the feed water. The flow of hot condensation through such heaters is apt to be irregular, and in most cases would be hardly sufficient to bring the feed water to the desired temperature, therefore it is customary to use a regular "closed" heater as a reheater supplied with exhaust steam from the main engine. Valved by-passes are provided as indicated for use in case of repairs or cleaning.

In some buildings, cold water en route to the feed-water heaters is forced through coils placed in drip tanks and blow-off tanks for the purpose of utilizing some of the heat that would otherwise be wasted, and to provide for cooling the water that would cause injury to sewer connections if discharged at too high a temperature. Until recent years the method most commonly adopted in large city buildings is shown in Fig. 2.

The receiver should be placed well above the suction valves of the pump to provide sufficient head to cause the water to properly follow the piston and prevent the racing of the pump.

Closed heaters are of the steam-tube or water-tube type, the expansion of the tubes being provided for, as a rule: (1) By the use of "U"-shaped tubes (2) by tubes fixed at both ends, the drum at one end being fitted with an outlet pipe working through a stuffing box; (3) by corrugated tubes fixed at both ends; (4) by the use of coils of brass or copper pipes.

*Abstract of paper by Mr. Wm. G. Snow, read at the semi-annual meeting of the American Society of Heating and Ventilating Engineers, at Chicago, July 19-20.

Tests on water-tube feed-water heaters are stated to have shown that when the water was pumped through the heater at such a rate that the final temperature was within 15° of the temperature of the steam, the transmission per sq. ft. of tube surface was about twice as great as when the water was pumped through so slowly that its final temperature was within 5° of the temperature of the steam. This shows that when a closed heater of this type is forced the efficiency of the heating surface is greatly increased, due to the more rapid rate at which the water is forced through the pipes, and to the greater difference between the temperature of the steam and the average temperature of the water.

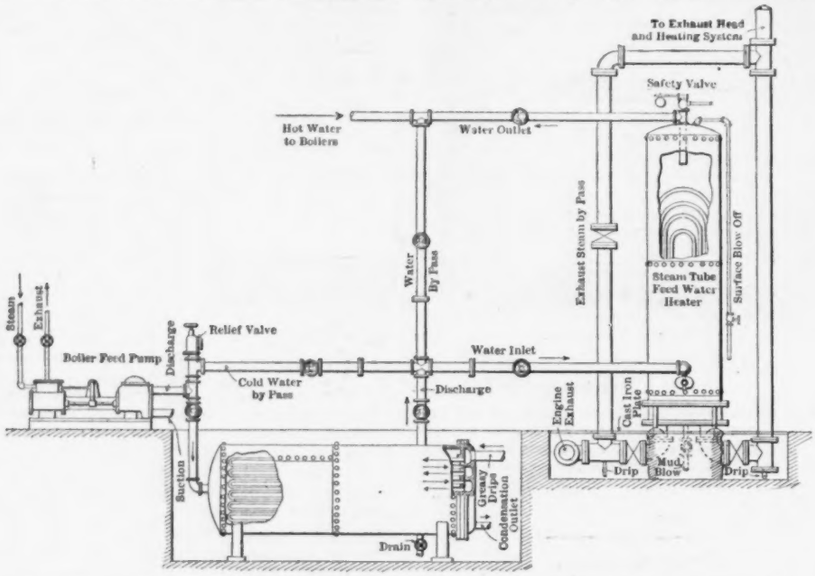


FIG. 1. SHOWING ARRANGEMENT OF CLOSED FEED-WATER HEATERS IN CONNECTION WITH HEATING SYSTEMS.

Steam-tube heaters have a relatively small overload capacity on account of the sluggish circulation of water between the pipes and the shell. Closed heaters generally contain from 0.3 to 0.5 sq. ft. of heating surface per HP., which, on the basis of raising 30 lbs. of water per hour from, say, 50° to 200°, is equal to a heat transmission of from 4,500 heat units to 0.3 or 0.5 sq. ft., or 13,500 or 9,000 heat units per sq. ft., respectively. As such surface becomes fouled by the accumulation of scale or sediment on one side and cylinder oil on the other, the efficiency of the heater rapidly decreases. It is probably safe to say that closed feed-water heaters bought in competition are seldom provided with sufficient surface to raise the temperature of the boiler feed water to more than 200°.

Closed heaters of the steam-tube type must have shells strong enough to withstand a pressure in excess of that in the boiler. A relief valve should be placed in the pump discharge line, otherwise excessive pressure will be produced in the heater when the boiler feed valves are suddenly closed, and will cause undue wear and tear.

Heaters arranged to circulate steam through the coils, the water occupying the space between the pipes and the shell, deteriorate, as a rule, more rapidly than when the water circulates through the coils surrounded by steam. Cast-iron shells are preferred by many engineers to those made of steel plate on account of their greater durability. Steam-tube heaters provide much greater storage capacity for hot water than do those of the water-tube type. Storage capacity means that more time is afforded for the settlement of impurities, any heavy sediment being removed through the mud-blow, lighter impurities being discharged through the surface blow-off.

The piping in Figs. 1 and 2 show full-sized by-passes, which are commonly employed to give the most efficient circulation of steam through the heater. The condensation from this steam is wasted to the sewer. Since only a portion of the exhaust steam is condensed, branch pipes to and from the heater considerably smaller than the main exhaust pipe are sometimes used. When this is done care must be taken to properly vent the heater to prevent air binding.

When water-tube coil heaters are used, one or more coils are sometimes connected with the hot water tank or generator that supplies hot water to the building on the same principle as a water-back in a range, the water being reheated by live steam coils in the tank.

Fig. 3 illustrates a modern method of handling the condensation from a heating system, at the same time providing for the heating of and additional water supply required by the boilers, the feed-water heater combining also the function of a receiver for returns from the heating system.

It is unnecessary to force all the exhaust steam through a feed-water heater of the direct contact or open type, since the condensation of about one-sixth of the engine exhaust is sufficient to heat the water necessary to take its place in the boiler. Assume, for example, that the engine is exhausting to the atmosphere with practically no back-pressure. The latent heat of steam at atmospheric pressure is 966 heat units. To heat 1 lb. of water from, say, 50° to 210°, requires 160 heat units, equivalent to the amount contained in about 1/6 lb. of exhaust steam. If all the exhaust steam is passed through the heater about 5/6 of it passes up the exhaust pipe uncondensed, and the passing of this oil-laden steam through the separator and the heater imposes an unnecessary burden on them, besides adding to the cost of the piping due to the by-pass required. A valved by-pass aside from the cost introduces an element of danger, since in case of faulty operation of the valves, the heater would be subjected to an excessive pressure which would be likely to cause its disruption.

With open heaters practically no resistance is offered to the ingress of exhaust steam, hence no appreciable increase in back pressure on the engine is necessary to keep these heaters properly supplied with steam. Direct-contact or open heaters, in which the steam and water come into direct contact, always retain their maximum original efficiency in the transference of the heat in the steam to the water. No fouling of surfaces affects this efficiency. The main criticism raised against them by some engineers is the dangers from oil getting into the boilers.

Of course the character of the water has much to do with the selection of a heater, the open heater being very commonly used in sections where bad water is encountered. This type of heater affords ample space for the settlement of organic impurities, and the high temperature secured precipitates the carbonates of lime and magnesia, which are deposited in a settling chamber provided for the purpose. To precipitate the sulphates, temperatures in the vicinity of 300° are required which are far beyond the range of exhaust steam heaters. This paper, however, is not a treatise on chemical heaters, although those of the open type are frequently fitted with tanks and apparatus for introducing chemicals for softening the water, which must be supplied in addition to the returns from the heating system or during the season when heating is not required.

Returning now to the question of eliminating the oil contained in the steam, the greater portion of this is removed by the separator; the coke filter, some [illegible] thick, being depended on to reduce the amount [illegible] to a harmless percentage. These heaters may easily be coked; in fact, all portions of the interior are [illegible] through large doors made tight by the use of [illegible]. The great and increasing number of such heaters in daily use would appear to the unbiased to be prot[illegible] factory proof that the oil question is successfully disposed of.

Some engineers object to the pumping of hot water, which is necessary when using direct-contact or open heaters, they claiming that the hot water causes rapid deterioration of packing and valves. When the water is set sufficiently high to bring the water level 5 ft. or more above the suction valves of the pump, no trouble should be experienced in pumping hot water, as there will then be sufficient head to cause the water to follow the piston and prevent racing. Sometimes when a heater is set low with reference to the pump, the substitution of lighter springs on the suction valves will overcome racing that may have been experienced.

As to the best material to use for valves for hot water service, many engineers prefer all metal valves instead of hard rubber. Such valves give good service and are considered by many to be worth the additional cost. Somewhat more care must be exercised in selecting piston packing than for cold-water pumps, especially in the case of end or center-packed plunger pumps, but this is only a detail, and hundreds of plants have pumps working successfully under the conditions stated.

The great storage capacity for hot water in direct-contact or open heaters is an advantage in meeting any sudden increase in the load on the boilers.

The condensation returned from the heating system is from steam that has passed through a separator. After this condensation has passed through the coke filter in the heater, it is in condition to be returned to the boilers. All steam condensed in heating the water in the heater is likewise returned to the boilers, and is no inconsiderable item of economy when water must be bought at city rates, amounting, as it does, to not far from one-seventh of all the water required.

There is no denying the fact that a greater amount of attention and more intelligent attention is necessary when the most efficient modern devices are used to save fuel. The extra cost of such additional attendance is, however, a small item in comparison with the saving secured.

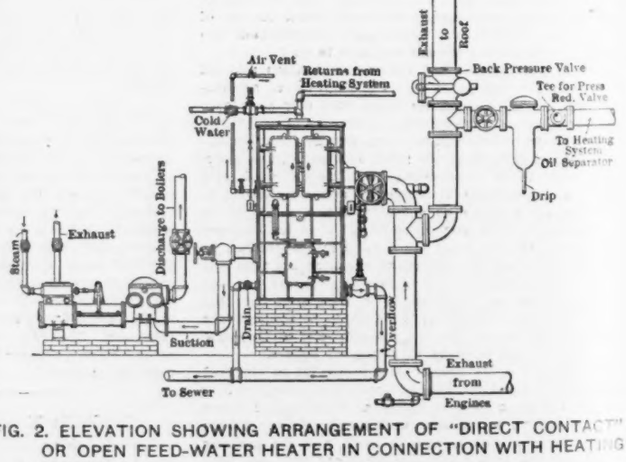


FIG. 2. ELEVATION SHOWING ARRANGEMENT OF "DIRECT CONTACT" OR OPEN FEED-WATER HEATER IN CONNECTION WITH HEATING SYSTEM.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The semi-annual meeting was held at the Auditorium Hotel, Chicago, July 19 and 20, with a fair attendance. While several papers were presented, the discussions were not of particular importance, and the proceedings were rather lacking in interest, owing partly no doubt to the hot weather. A notable point, however, was the attention given to hot-air heating, a system which has come to be popularly considered as inefficient and unsatisfactory. The many poor results seem to be largely due to the fact that an engineer is rarely called upon to design the plant, but the installation is left in the hands of builders and furnace dealers.

At the morning session on July 19, a brief opening address was made by the President, Mr. John Gormly, and the Society at once proceeded with the regular program.

HEAT LOSSES AND HEAT TRANSMISSION.

This paper was by Mr. Walter Jones, of Stourbridge, England, and dealt with the great lack of unanimity in opinions as to this matter, and also the conflicting tables and formulas given by various writers. Thus in relation to the heat loss through walls and through glass, the figures by various authorities range from 2 sq. ft. to 10 sq. ft. of wall equivalent to 1 sq. ft. of glass, a variation of 400%. In the same way, the formulas for a given temperature in a given room under given conditions show results ranging from 92 to 164 sq. ft. of radiator surface, a variation of 76%. On this point the author makes the following remarks:

The wide divergence of opinion on the first or elementary basis of providing for a heating installation is not only interesting; in my opinion it is humiliating. Can we wonder that heating engineers often fail to get the results they strive for? The marvel is that they are ever successful. One of the first and most important problems for heating engineers to decide is an approach to uniformity, by adopting some definite data as to the actual surface losses by glass, wall, etc., and the actual heat transmission from the pipe or radiator, that will provide for the surface losses of glass, wall, or other material.

The method suggested by Mr. Jones is simple, and he believes it to be more reliable than many of the complicated formulas. To obtain a temperature of 70° F. in rooms of less than 5,000 cu. ft. in ordinary buildings, with outside temperature at zero and water at 170°, the calculation would be as given below; for larger rooms, however, the figure for cubic capacity would be increased, the two other figures remaining constant.

$$\left.\begin{array}{ll}\text{Glass (ft. super.)} & \div\ 2\\ \text{Wall (ft. super. exposed)} & \div\ 6\\ \text{Cubic capacity (feet)} & \div\ 90\end{array}\right\} = \text{Ft. super. of radiation.}$$

It would be a great convenience to use two factors as constants, such as a divisor of 2 for glass and 6 for wall; and an elastic divisor for the cubic capacity that would compensate for the varying thickness of the walls, and for the larger volume of air (proportionately) to the wall or other cooling surfaces; the result thus obtained for stated temperatures, such as 70° inside, 0° outside, and water 170° to be called unity. A table of factors of decimal equivalents could then be formulated to cover a wide range of temperatures, inside or outside of the building.

There was no extended discussion, but reference was made to the effect of wind in cooling exterior walls; when such walls are warm or hot the heat causes a vertical wind or draft which has a cooling effect, so that the radiation surface required to maintain the interior temperature increases in greater proportion than the temperatures to be maintained. Some speakers spoke of plants which had been unsatisfactory owing to the neglect of this feature of the problem.

At the afternoon session, preliminary reports were made by the special committees on (1) Sizes of pipe; (2) Steam heating; and (3) Hot water heating. The suggestion was made that in view of the importance of the work of committees and the difficulty of getting together the members of committees, it would be well for the Society to undertake to pay the expenses of members on committee business. This was not supported, however, and the motion was withdrawn. A number of Illinois members have presented an application for a charter for a local chapter of the Society, and while there was little objection made in the consideration of the matter, the meeting got very much tangled up in a long discussion as to what action could or should be taken. The application must be acted upon by the Board of Governors at the annual meeting in January, and eventually a resolution was passed expressing the opinion of the meeting in favor of granting of the desired charter.

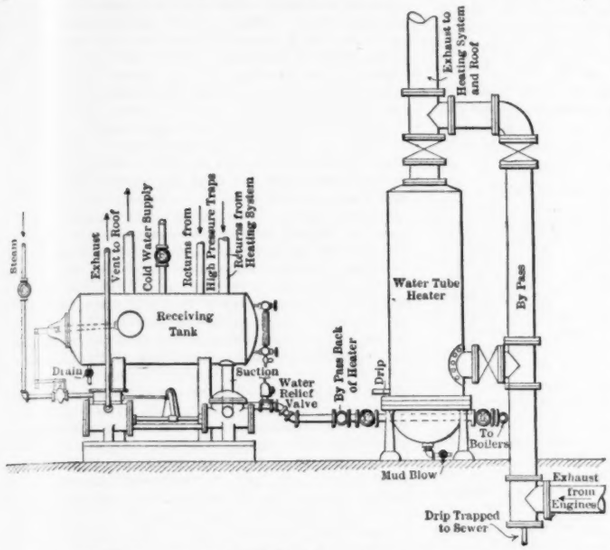


FIG. 3. SHOWING ARRANGEMENT OF PUMP AND RECEIVER AND CLOSED FEED-WATER HEATER IN CONNECTION WITH HEATING SYSTEM.

A paper on "The Elimination of Redundant Parts in the Forced Circulation of Hot Water" was then taken up. This was by Mr. A. H. Barker, of Trowbridge, England, and was read by Prof. Kinealy.

On Friday morning, July 20, two papers were read, both of which are printed elsewhere in this issue: the first was "The Use of Feed Water Heaters in Connection with Heating Systems," by Mr. Wm. G. Snow, and the second was on "Fads and Fallacies in Hot-Air Heating," by Mr. R. S. Thompson.

AN IMPROVED METHOD OF HOT-AIR HEATING.

This paper, by Mr. A. O. Jones (Battle Creek, Mich.), described a system which was stated to be already in use in a number of cases.

The system differs from those in common use in that ventilation is secured in all rooms, and the basement is not filled with warm-air pipes, there being only half the number of pipes ordinarily used. These pipes are connected to improved warm-air registers placed in the wall of each room on the first floor, with a wall pipe continuing from the top of each register box to a similar box in a room on the second floor. For heating each two rooms (one on the first floor and one on the second) there is a basement pipe with capacity equal to the capacity of two pipes necessary for heating these two rooms separately. The advantages to be gained are that ventilation is secured in all the rooms, as these registers are provided with a double metal box, arranged with an air space between the inner and outer casing, and a ventilating opening, where air is drawn out of the rooms being heated and is conducted through the air space upwards.

The heat of the wall pipe causing an upward current insures a rapid movement of the foul air to a point in the attic directly above the registers, where it should be conducted through vent pipes to a chimney flue not used for any other purpose. It will be seen that cellar air (as ordinarily used for protection when double wall pipes are used) is not allowed to enter the space between the two casings of the wall pipe, but, instead, air is drawn from the rooms.

WALL RADIATORS AND LONG PIPE COILS.

In this paper Mr. J. A. Donnelly (New York, N. Y.) set forth the advantages of wall radiators for factory heating. In the discussion he stated that they are of better appearance than pipe coils and are more easily freed from air. The selection, however, is usually governed to a large extent by the wishes or opinions of the factory managers and owners, but Mr. Donnelly stated that if the matter were left entirely to his judgment and the cost were the same in both cases, he would use the radiator system as being the better. The following is an extract from the paper:

Although the use of wall radiators in place of pipe coils has been advocated quite broadly by manufacturers, they have been mainly used only in place of short coils. A prejudice seems to exist against the use of long radiators and coils that is not warranted by the facts in two-pipe steam work. The limit in length of a coil, considering only the proper circulation of steam through it, would be that each individual pipe should not have in itself more surface than good practice would warrant putting on that size pipe. Thus, a coil made of 1-in. pipe 120 ft. long would have 40 sq. ft., and one of 1¼-in. pipe 172 ft. long would have 75 sq. ft. of heating surface in each pipe this would therefore be about the limit of length if that were the only factor. The easy control of the proper heating of each floor should, however, be taken into consideration; and this of itself seldom warrants coils exceeding 100 ft. in length, and therefore this has usually been considered as the limit of good practice.

This substitution of wall radiators for pipe coils, aside from any argument as to the relative efficiency of each under ordinary conditions or under the conditions of special tests, is many times preferred by the factory designer, and should be by the heating engineer, as it concentrates the heating surfaces under the windows and leaves a larger amount of wall surface free for other purposes, both of which are very desirable features. The total amount of wall surface occupied by the wall radiation is also less than half that occupied by the pipe coils. In regard to the comparative cost, the wall radiators erected in place usually cost less than the coils, though this is affected greatly by the variance in the cost of pipe and labor.

A number of topics for discussion were on the program, and nearly all of these received some attention, but none received any extended discussion and very little matter of importance resulted. Subjects dealing with radiators seemed to be of most interest, and there were some remarks as to the desirability of collecting information as to the comparative life of wrought iron and steel pipe in steam and hot-water heating systems. As to the relative advantages of chimneys and forced-draft, one speaker favored the latter, but nothing was said on the other side of the question.

The only entertainments were a carriage drive for the ladies of the party, and a banquet on the second evening.

SPECIAL COMMISSIONERS' REPORT ON IMPROVED RAILWAY TERMINALS AND A NEW MUNICIPAL BRIDGE OVER THE MISSISSIPPI RIVER AT ST. LOUIS, MO.

A comprehensive plan for the improvement of the present railway terminal facilities at St. Louis, Mo., has been reported by the Municipal Bridge and Terminals Commission of that city. This commission was authorized by ordinance of the Municipal Assembly and appointed by the Mayor in the early fall of last year. As authorized the commission was to advise what additional or improved facilities and what improvements in operating methods are necessary to make the railway terminals at St. Louis adequate for the present freight traffic of the city; to recommend plans for these additions and improvements, and to prepare ordinances necessary for the inauguration of the work. The commission secured the services of Mr. Robert Moore, M. Am. Soc. C. E., and Mr. Albert T. Perkins as consulting engineers, and the report of these gentlemen is now submitted as a preliminary report of the commission. The following is an abstract of the parts of the report that are of most general interest:

The freight tonnage received and forwarded at St. Louis and East St. Louis has practically doubled in seven years (from 20,042,169 tons in 1898 to 39,141,663 tons in 1905).

The railroad terminals of the St. Louis district have developed in four distinct groups:

1. The Mill Creek Valley, which is not only the geographical and business center of the city, but the natural railroad center to which favorable access may be had from all directions.

2. South St. Louis, south of Chouteau Ave. and east of Broadway.

3. North St. Louis, north of Franklin Ave. and east of Broadway.

4. East St. Louis.

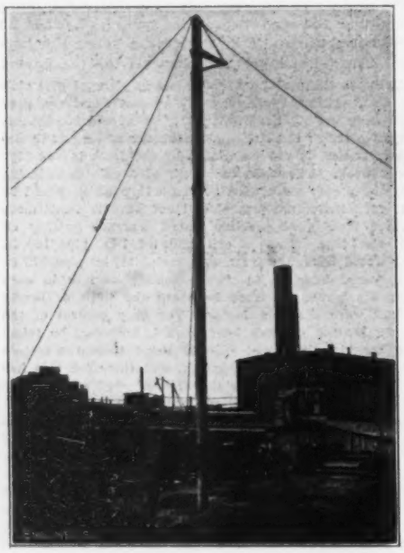


Fig. 1. View of 13-In. Diameter, 61-Ft. Reinforced Concrete Pile Formed by Rolling and Erected as a Pole with Yard Arm for Bending and Torsion Tests.

MUNICIPAL CONTROL.

In the three sections on the west side of the river we believe it to the interest of the city that, subject to the maintenance of streets necessary for public use, and subject to any desirable reservations for park and other public purposes, every facility should be given for acquiring and utilizing property for railroad purposes and, for reasons which we shall explain further on, it seems to us desirable that to a considerable extent the property should be acquired and franchises granted in such shape that the property can be used for all railroads desiring to do business in those localities, rather than that it should be tied up to the uses of single railroad companies.

As, under Government control, the field of action of railroad companies is becoming more and more limited to the manufacture and sale of transportation; as the room in a large city for manufacturing, storage and railroad purposes becomes more and more limited and costly; and as the total cost, direct and indirect, of transportation of commodities from the point of production to the point of consumption is more closely figured, it is desirable that the friction in handling terminal work and the duplication of facilities in any one section should be reduced to a minimum. On the other hand, efforts should be directed to securing facilities in those parts of the city where commercial and manufacturing interests center, through which our people may deal with all the railroads in the least burdensome and most economical manner.

While we do not oppose, but would encourage a considerable development of individual railroad facilities, it seems to us that the development of freight houses and team tracks most in line with economy and the most widely extended service is that they should be furnished by a combination of the various railroads, operated for the joint benefit of all the railroads and the public. The association or agency that provides these facilities should not be a corporation doing terminal business for a direct profit, but should be organized and clearly recognized as the agency of the combined railroads, acting for and representing each.

THE PROBLEM STATED.

The problem before the commission is divided into two parts.

(1) That of providing facilities in St. Louis for the prompt and economical receipt and delivery of freight.

(2) That of providing for the interchange of freight between the two sides of the Mississippi River, that is, the problem of bridges and ferries.

FACILITIES NEEDED.—The land required for railway terminal facilities may be divided roughly into two classes: (1) That required for (a) freight houses, (b) team tracks and (c) sidings to industries; (2) that required for (a) classification, team and storage yards, and (b) roundhouses and shops.

The second class is of only indirect interest to the public. Such facilities are generally and properly located several miles from the warehouses and tracks at which the public does its business with the railroads. Our immediate concern with these is not as to their actual location and arrangement, but to recommend that to the regions especially adapted to those purposes liberal franchises be granted for their development. There is still ample room for these in North and Northwest St. Louis, in the Carondelet district, and in East St. Louis.

While we shall have some recommendations to make in regard to needs for larger classification and storage yards in certain localities, our main recommendations will be in regard to development of freight houses and team tracks, which must naturally be close to crowded business sections of the city, and in regard to the arteries that connect them together, and with the classification and storage yards.

Following this statement of the problem, the report points out the possibilities of the waterfront for the location of freight houses providing the available area is properly filled and graded. Details are then given of the team track facilities now available at the various individual depots, and the conclusion is drawn that there is immediate necessity of (1) additional and improved team track room, and (2) additional and improved freight-house room.

TEAM TRACKS.—It is estimated that in order to handle satisfactorily the business of the immediate future not provided for by the team tracks of the separate railroad companies, the team-track room of the Terminal Railroad Association should be at least doubled. The team tracks between Twelfth St. and Sixteenth St., which now give room for only 189 cars, should be improved and enlarged to about four times their present capacity. Those at Compton Ave. should be, and can easily be, more than doubled. The team track facilities at the foot of Biddle St. and in the neighborhood of North Market St. and Branch St. should be at least double. Short team tracks should also be provided at several points on the west belt, such as Easton Ave.

In connection with this matter of team-track room, we call attention to the importance of economy in its use, and this economy must, of course, be largely in the nature of a rapid loading and unloading of cars. Twenty to thirty car lengths of team-track room, with the necessary alleys, switches, etc., can be put on an acre of land, and where land is very valuable the land interest charge alone for a car length of team-track room may be equal to the entire revenue on a car of low-class freight left on the track for not uncommon periods.

For example: If an acre of land on which there are 25 car lengths of team track costs $200,000, the interest charge at 4% would be $320 per year, or about $1 per day (excluding Sundays and holidays) per car length of team-track room. If the property were assessed at half its cost the taxes in this case would be $84 per year, or 27 cts. per day per car length. On an estimated average use of each car length of such track for 100 shipments per year the land, interest and taxes, even before the construction of tracks and paving, would be $3.81 per carload handled. Actual prices recently paid in St. Louis for land for this purpose have in some cases exceeded the above figure.

Manufactories and warehouses should, wherever possible, provide private tracks for the loading and unloading of their carload freight, running these tracks, where land is very valuable, under the buildings.

FREIGHT HOUSES.—In our recommendations as to rearrangements of and additions to freight house facilities, we first call attention to some definite tendencies which our investigations have indicated, toward certain methods of handling warehouse freight. And in connection with this we ask you to consider the cost of additional ground for extension of one-story freight houses in congested parts of the city.

If 250 tons per day of additional merchandise are to be taken care of and the properly located ground on which to construct the necessary houses and tracks cost $500,000, the land interest charge at 4% would be 26 cts. per ton of freight handled. If the property were assessed at half its cost the taxes would be nearly 7 cts. per ton, making the total land interest and tax charge about 33 cts. per ton. The cost of elevating freight (including interest on plant, maintenance and direct and indirect operating expenses) has been carefully figured at 12 to 14 cts. per ton.

There is a tendency in many of the larger cities to provide stations for less than carload freight at different business centers. For example, the Pennsylvania Co. has seven stations in Pittsburg, at four of which freight is received for all its divisions; the other three receiving each for one division; in addition it receives for all divisions at the Pittsburg Terminal warehouse. In Philadelphia it has 31 stations, at 28 of which freight is received for all divisions. In New York proper it receives at four stations, and in Brooklyn at four stations. The New York Central Co. receives at eight stations in New York proper and at four stations in Brooklyn. Other lines have similar arrangements. When the volume of traffic allows, merchandise cars are loaded through to destination or to junction points; otherwise the freight is loaded in cars for large near-by transfer stations. We find in Eastern cities the freight is generally rehandled and forwarded from the transfer stations the same night it is received.

Another tendency is toward the double-decking of freight houses to provide sufficient room for increasing business, especially for inbound freight, as against spreading out on very expensive land. For example, the "Panhandle" house of the Pennsylvania Co. at Pittsburg has two stories, with tracks on the first floor [illegible] the station being on a hillside, driveways for both stories are convenient. Inbound merchandise is unloaded early in the forenoon on first floor and at once elevated to the second floor, where it is delivered to teams. Outbound merchandise is handled on the same platform as the inbound on first floor, and the inbound cars are loaded without switching. Hydraulic elevators and 2 [illegible] ft. platform trucks, similar to those at Cupples station, are used. A second story is planned for the Pittsburg & Lake Erie station at Pittsburg, with driveways for both floors. Owing to the shortage of freight house room, the Pittsburg & Lake Erie now loads about half of its outbound merchandise into cars on team tracks, as the Illinois Central now does at the St. Louis Tenth St. station, but in order to weigh load in station order, and store carefully its merchandise, and in order to increase its average carload and to save switching, it proposes both to lengthen and double-deck the station in question and elevate the inbound freight as fast as unloaded to the second floor.

At the Wabash Pittsburg station the tracks are on the fourth floor, an admirable system of hydraulic elevators handling the freight between the street floor and the other floors. The four floors are conveniently arranged for handling different classes of freight and are directly connected with a series of modern warehouses, to and from which freight is handled on 3 × 6 ft. platform trucks.

The Philadelphia & Reading house at Philadelphia has a second story, to which inbound freight is raised by elevators and delivered from the second story direct to driveways. A further working out of this plan is the providing of storage room for inbound freight by erecting stations several stories in height. A part of the new inbound station of the Pennsylvania Co. at Pittsburg is four stories high, and of very heavy construction for storage. The new station of the Baltimore, Ohio & Southwestern at Cincinnati, has six stories for storage warehouse purposes, equipped with the most modern electrical elevators and other devices. The Central Railroad of New Jersey is building a $1,000,000 inbound warehouse at Newark, six stories high, with electric elevators, etc.

In some cities, as in Baltimore and Washington, the railroads, in order to get rid of inbound merchandise in the quickest manner and with the least freight house space, are making direct store-door delivery to consignees, within certain limits, by contract with a drayage company.

TERMINAL WAREHOUSES.—Another tendency is toward the construction of transfer or terminal warehouses, embracing aggregations of jobbing or manufacturing concerns, which rent space of the warehouse company, the latter providing the assembling and receiving room for freight and arranging with the railroads to make its system of warehouses a railroad station, as in the case of Cupples Station, in St. Louis.

One of the most modern plants of this kind is that of the Pittsburg Terminal Warehouse & Transfer Co., at Pittsburg, which not only has a most complete system of warehouses, equipped with electric elevator service, cold storage, etc., and with large assembling platform and track room for unloading and loading freight for the railroads, but also a river connection, with elevators adjustable to the various stages of water, where an extensive business is done with boats.

The Bush Terminal at Brooklyn receives and delivers freight for all New York roads, not only for the tenants of its extensive warehouses and its steamship piers, but for the public as well. Connected with its plant are buildings for manufacturing purposes on a large scale, to which electric power is furnished, and for which not only is switching service furnished, but L. C. L. freight

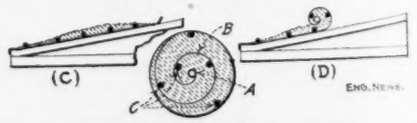


Fig. 2. Sketches Showing Section of Rolled Pile and Explaining Method of Rolling.

is received at central points in the manufacturing buildings and taken to the main assembling station for loading to the various railroads.

PROPOSED FREIGHT HOUSE IMPROVEMENTS.

As the first item in the rearrangement and improvement of freight house facilities, we recommend the consolidation of the Cupples Station and Tenth St. Terminal Railroad Association Station business.

The second scheme which we recommend is to serve the jobbers and manufacturers of Washington Ave. and the district north of Washington Ave. with receiving and delivery facilities for all railroads not already having stations north of Washington Ave. This proposed second station is also intended to supply storage room of a modern character, to which freight can be tracked from the cars. This plant contemplates a large inbound and outbound freight house, six or more stories high, with an eastern

frontage of some 1,200 ft., extending along the harbor line north of Eads Bridge, with a width of approximately 160 ft.

In addition to this main freight house a warehouse storage extension from Eads Bridge north to Franklin Ave. might be carried over the Merchants' Terminal elevated structure to Main St., with a frontage on Main St. extending from a little north of Washington Ave. to the south line of Franklin Ave., a distance of 500 ft.

The third scheme, which we think should be worked out on a smaller scale, is a freight station for the use of all roads in the Mill Creek Valley between Vandeventer Ave. and Tower Grove Ave. If possible, we believe the T. R. R. A. should acquire trackage rights of some kind into that neighborhood in order to provide such a house, as a very considerable business center is developing there, and the wagon haul from that district to the downtown freight houses is becoming almost impossible.

PROPOSED NEW RAILROAD ENTRANCE.

Another requisite for adequate and satisfactory railroad service is a new and better entrance into the city from the east side of the river. The two entrances now in use are the Merchants' Bridge and the Eads Bridge, including the tunnel. Of these the first in the volume of trackage, as well as in the order of time, is the Eads Bridge.

The location of this bridge in the center of the city, however, though absolutely necessary when the bridge was built, was for railroad traffic highly unsuitable, as experience since then has demonstrated with ever-increasing force. For this one reason is that the East St. Louis approach is so located that the trains from southern lines can cross the bridge only by backing up, and the same thing is true in returning. This necessity, though inconvenient and objectionable, is not serious, as compared with the further fact that from the west end of the bridge the Mill Creek Valley, which is the natural railroad center of the city, is accessible only through a tunnel more than 4,000 ft. in length. Even for light traffic, the smoke of this tunnel has always been a source of discomfort and possible danger both to live stock and to passengers. For the dense traffic of crowded hours it is almost intolerable.

The only complete remedy is a new bridge which shall be so located as to require no tunnel approach, and which shall, at the same time, be equally accessible by all of the east side roads—from the South as well as from the North and East. For this bridge the most natural and in every way the best location is at the east end of the Mill Creek Valley, at or near the foot of Poplar St. In crossing the river the main span extends from harbor line to harbor line, a distance between centers of piers of 1,600 ft. The reasons for a span of this length are:

(1) That under the provision of Section 3 of the act of February 27, 1901, which requires that a bridge at St. Louis below the Eads Bridge shall be built with "an unbroken and continuous single span," nothing else appears to be legally possible, and,

(2) that piers in the river at this point would so greatly interfere with boats seeking to land or to leave the harbor as to make it almost inaccessible. To ferry traffic, in particular, which is certain always to be of great and growing importance, they would be obstacles well nigh fatal. So that even if the law were not as it now is, it ought to be made so. A span of this length is, of course, not desirable, but it is entirely practicable, and, for a bridge of the importance of this one, its cost is not prohibitive. In fact, a combined railroad and highway bridge with a span of 1,800 ft. or 200 ft. longer than the one here proposed, is now far along in construction over the St. Lawrence River, a few miles above Quebec.

The clear height of the main span above the city directrix, that is, the curb level on the wharf between Market and Walnut Sts., is 60 ft. This is less by 15 ft. than is called for by act already cited, but as it is 10 ft. more than now exists at the Merchants' Bridge and at the Eads Bridge, and is all that is needed, the law ought easily to be so changed as to permit it. But even if this cannot be done and the full 75 ft. clearance be required, it will not greatly increase the cost, though it will increase the grade of the approaches and impair the capacity of the structure. The grades as now planned will not exceed say, 1%, on either side of the river, as against 1½% in the tunnel and on the east approach of Eads Bridge.

From the foot of the west approach to the junction of the two East Side branches, the proposed new structure is designed to carry four railroad tracks. The two branch lines are designed for two tracks each.

In estimating the cost of a structure of the weight of this one, a critical, if not decisive, element is the depth to bedrock, on which alone can the main piers be safely rested. On the west side, previous excavations and soundings above and below Poplar St. make it entirely safe to say that this depth cannot exceed 36 ft. below low water, and it may be considerably less. On the East Side, however, the available information was so scanty that two test borings were put down on the east bank of the river near the center line of the bridge. Though these borings were not on the site of the proposed pier, which was more than 100 ft. out in the water, they make it reasonably certain that the depth to bedrock will be about 98 ft. below zero of the St. Louis gage, or 3 ft. lower than at the east abutment of the Eads Bridge. Other surveys necessary to establish the proper location on the East Side were also made. A careful estimate based upon the data thus obtained, gives the following approximate cost:

West approach	$740,00
Main river span, between anchor piers	4,520 000
East approach	510 000
North branch	521,000
South branch	422,000
Ties and rails in place	210,000
Signal system	57,000
Total	$6,980,000
Add for right-of-way, general expenses and contingencies	1,020.000
Grand total	$8,000,000

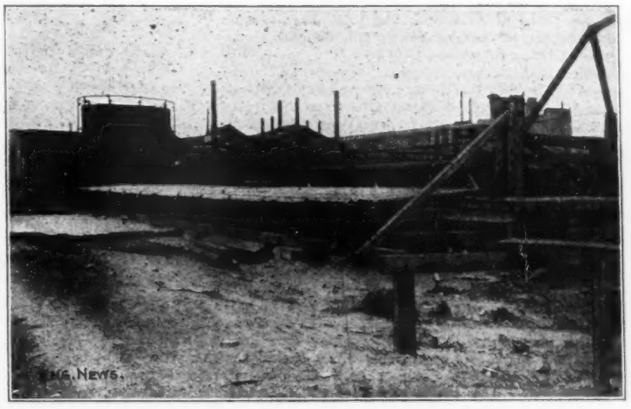


FIG. 3. MACHINE FOR ROLLING 61-FT. REINFORCED CONCRETE PILES.

A METHOD OF MANUFACTURING REINFORCED CONCRETE PILES BY ROLLING.

A method of manufacturing long piles or poles of reinforced concrete without forms by simply rolling a sheet of concrete and metal netting into a solid cylinder is illustrated in the accompanying cuts. A test pile fabricated in this manner is shown erected as a pole in Fig. 1; the pile has been so erected that it may be tested by handling and by bending and twisting with ropes attached to the top and to the yard arm. This pile is 61 ft. long and 13 ins. in diameter and weighs 4 tons. It was erected by means of an A-frame and block and tackle. The interesting feature of this pile is, of course, the method of its manufacture by rolling.

A cross-section of the pile is shown by Fig. 2; in this drawing A is a steel pipe, B is a coiled sheet of expanded metal or wire netting, and C are longitudinal steel rods. The pipe A forms the shaft or mandril on which the pile is rolled or wound, and the netting B and rods C constitute the reinforcement. The apparatus for rolling the pile is shown by Fig. 3; in this apparatus there is a traveling platform between which and the roller the pile is formed. The winding pipe or mandril is set in line of the axle of the large spur wheel shown.

In operation the reinforcing netting with the longitudinal rods attached is spread on the platform and covered with a layer of concrete as indicated by the sketch C, Fig. 2; one edge of the netting is attached to the edge of the platform and the other edge to the winding pipe or mandril. Thus arranged the winding mandril is rotated and the netting and its covering of concrete is wound or coiled up as indicated in sketch D, Fig. 2. At the same time and as fast as the netting and concrete is coiled up the platform A moves under the roll B and the roll itself rotates. The forming cylinder of concrete is by this means kept under constant and heavy pressure between the platform and roller. To bind the roll of concrete wires are wound around it at close intervals and tied. The wire is contained on spools arranged beneath the moving platform. These spools are spaced every 6 ins. along the pile and fastened to the wire mesh, so that when the pile reaches the lower edge of the platform it can be revolved about the axis, causing the wire to be wound on the pile. In this manner the wire is passed around the pile a number of times and secured. At the driving end of the pile, the spools are placed 4 ins. apart, for the first 10 ft. of the pile, and then 6 ins. apart for the remainder of its length, forming a very secure binding on the outside. Then by means of a long removable shelf, which contains the flushing material, as the pile revolves, it becomes coated on the outside and is flushed up smooth. A point is rolled on the pile, if necessary, for driving purposes during the rolling process. The finished pile is rolled off the platform onto a suitable table to harden, after which it may be stored until driven. The machine shown in Fig. 2 is capable of rolling piles 61 ft. long, but by enlarging the machine the inventor claims to be able to roll 100-ft. piles without difficulty.

The test pile shown in Fig. 1 is only one of several that have been successfully rolled. In erecting this pile as a pole it was hoisted by a tackle attached near one end, the other end dragging on the ground exactly as a wooden pole would be handled, and showing no ill effects from the treatment. The pile was also suspended from the middle so that the ends sagged down, and, although the deflection of the end amounted to 6 ins., the pile, when released, returned to its original straight form, and a careful examination failed to reveal any cracks in the concrete. The pile being wound with a pipe core can be sunk by a water jet or it can be driven by a hammer like any other reinforced concrete pile. Fig. 4 shows the special driving cap devised for hammer driving.

The cost of a pile 61 ft. long and 13 ins. in diameter is about $60. This pile is reinforced to carry its own weight in handling. A pile 30 ft. long could be made and driven for $1 per foot, so the price of a 60-ft. or 100-ft. pile would be no guide for estimating the cost of piles of shorter length.

The pile illustrated, the method of its construction and the apparatus for constructing it, are the design of Mr. A. C. Chenoweth, 16 Court St., Brooklyn, N. Y., and have been patented by him. We are indebted to Mr. Chenoweth for the information from which this description has been prepared.

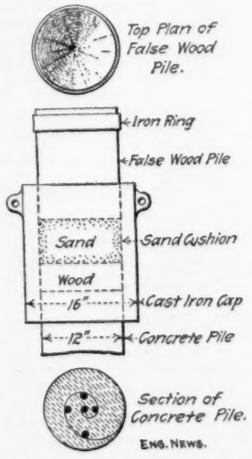


Fig. 4. Special Cap for Driving Rolled Reinforced Concrete Pile.

NIAGARA POWER PERMITS have been granted by the Secretary of War in accordance with the law passed by Congress a few months ago on the subject of draft of Niagara water. Secretary Taft has granted temporary permits as follows: Niagara Falls Power Co., 8,600 cu. ft. sec.; Niagara Power Co., 4,000 cu. ft. per sec.; Lockport Hydraulic Power Co., 500 cu. ft. per sec. from the

upper level of the Erie Canal and 333 cu. ft. per sec. from the lower level at Lockport. The total draft of water which the act of Congress allows him to issue permits for is 15,600 cu. ft. per sec.

Permits have also been issued empowering the Niagara, Lockport & Ontario Power Co. to import into the United States the equivalent of 25,000 HP. from the Ontario Power Co., a Canadian company generating electric Power at Niagara Falls; and empowering the Niagara Power Co. to import electric energy from the Canadian Niagara Power Co. at a rate not exceeding 25,000 HP. Capt. Charles W. Kutz, Corps of Engineers, U. S. Army, has been designated by the War Department to make a report on Canadian power.

TWO SERIOUS RAILWAY ACCIDENTS occurred on American railways during the past week. On the evening of July 22 a local passenger train and an extra freight train on the Seaboard Air Line collided head-on near Hamlet, N. C. At least 20 persons were killed. The accident was caused by the operator at Rockingham, one station away from the scene of the wreck, who failed to deliver stop orders to the passenger train. A more unusual accident occurred on the Great Northern Ry. near Camden, Wash., on July 23. A west-bound fast passenger train, when emerging from a tunnel on the shore of Diamond Lake, was derailed and thrown down a high embankment into the lake. Possibly ten persons were killed.

AN ELECTRIC RAILWAY TERMINAL STATION and public service building has been completed at Milwaukee by the Milwaukee Electric Ry. & Light Co. It is adjacent to the Union Station, and is a handsome structure with very elaborate interior finish. It is 320 × 200 ft. in plan, and four stories high, but is built with a view of being ultimately made 12 stories high. On the first floor are eleven tracks running through the building, and six of these have pits for inspection and running repair work; a fire wall divides this open space into two parts. Along the main front are the entrance hall, waiting room, elevators and the company's salesrooms; at the rear are the repair shop, storeroom and room for the emergency wagon. On the second and third floors are the company's offices, testing and drafting rooms, an auditorium with stage for public meetings; also a library, reading room, dining room and other accommodations for the employees. On the fourth floor are the general manager's private offices, a printing office, etc. A power plant is located in the basement and has three non-condensing steam turbines, each coupled to a 4,000-volt, 60-cycle, alternating-current generator of 1,500-KW. capacity. There are ten Edgemoor horizontal water-tube boilers of 500 HP. each, with Hawley down-draft furnaces. Coal is delivered to a bunker by wagons or the company's dump cars, but owing to the limited headroom and other conditions the firing is done by hand. Ashes are conveyed by a telpherage system or traveling trolley hoist to an elevator which discharges them into cars on an outside track. There are two brick smokestacks. The cars are not reversed at the station, but enter at one end and leave at the other.

HORIZONTAL TWIN TANDEM GAS ENGINES will be used extensively in the new plant which the United States Steel Corporation is building under the name of the Indiana Steel Co., at Gary, Ind. Seven 2,000-KW., 25-cycle, 2,300-volt generators and two 2,000-KW., 250-volt direct current generators will each be direct connected to this type of engine. Eight 3,000-HP. blowing engines of this type will also be used; all engines operating on blast furnace gas.

THE ERIE R. R. will build its main line through Cleveland, Ohio, according to press dispatches, at a cost of $10,000,000. Double track will be laid from Meadville, Pa., to Cleveland, thence to Sterling, Ohio, making a total of about 100 miles of new road.

THE CAPE TO CAIRO RAILWAY and the Cape to Cairo Telegraph System, including telephones, are endowed to the extent of £1,200,000 by the will of the late Alfred Beit. The will, in regard to this endowment, reads:

> I believe that by the promotion, construction and furtherance generally of railways and telegraphs, including wireless telegraphy, telephones or other methods of transmission of persons, goods and messages, civilization will be best advanced, especially in Africa, for the benefit of the inhabitants of that country, whether native or immigrant, and I know from experience how difficult it is at times to find funds for the construction of such methods of transmission in new and undeveloped countries.
>
> Provisions are therefore made
>
> for the purpose of assisting the promotion, construction, equipment or furtherance of any such methods of transmission as aforesaid in South and North Rhodesia, Portuguese Africa, both east and west; German East Africa and such other parts of Africa as may be traversed in establishing what is known as the Cape to Cairo railway and the Cape to Cairo telegraph system, including telephones.

PERSONALS.

Mr. T. H. Bacon has been appointed Assistant Chief Engineer of the Chicago Great Western Ry.

Mr. H. L. Charles has been elected General Manager of the Bingham Consolidated Mining & Smelting Co.

Mr. Chas. S. Hill has severed his connection with the Engineering News Publishing Co., taking effect July 20.

Mr. Joseph B. Bishop has been re-elected Secretary of the Isthmian Canal Commission at a salary of $10,000 a year.

Mr. H. S. Rogers has been appointed Engineer of Maintenance of Way and Construction for the Illinois, Iowa & Minnesota Ry.

Mr. H. J. Shaw has been appointed Assistant Engineer of the Toledo Division of the Pennsylvania System, to succeed Mr. Hugo Eichler, resigned.

Mr. C. D. Quick has been made Superintendent of Works of the Alma Cement Co., of Wellston, Ohio, to succeed Mr. J. N. Kennedy, resigned.

Mr. H. L. Hungerford has been appointed Superintendent of the Memphis Division of the Iron Mountain Ry., with headquarters at Wynne, Ark.

Mr. W. C. Webster has been made Manager of the New York sales office of the Westinghouse Electric & Mfg. Co., to succeed Mr. E. W. T. Gray, resigned.

Mr. L. B. Allen has been appointed General Superintendent of the Wyoming District of the Chicago, Burlington & Quincy Ry., to succeed Mr. J. R. Phelan, resigned.

Mr. Andrew M. McGill, General Foreman of the Mechanical Department of the New York, New Haven & Hartford R. R., has become Master Mechanic of the Lehigh Valley R. R.

Mr. Wm. H. Chadbourn, Jr., U. S. Assistant Engineer at Beaver, Pa., has been appointed Chief Engineer of the Chicago Great Western Ry., succeeding Mr. A. W. Munster, who has resigned.

Mr. S. Kedzie Smith has resigned as General Superintendent of the Utah Fuel Co. to become District Manager of the Dearing Coal Co., of Chicago, Ill., with headquarters at Terre Haute, Ind.

Mr. A. E. Kastl, M. Am. Soc. C. E., has been appointed Engineer of the Dam and Reservoir Department of the Metropolitan Water-Works of Boston, at Clinton, Mass., to succeed Mr. T. F. Richardson, resigned.

Mr. H. S. Corrington, Chief Dispatcher of the International & Great Northern R. R., at San Antonio, Tex., has been appointed Assistant Superintendent at Taylor, Tex., of the San Antonio Division of the road.

Mr. G. A. Roullier, M. Am. Soc. C. E., of Flushing, L. I., and Mr. R. H. Bethel, of New York City, have formed the firm of Roullier & Bethel, Civil Engineers and City Surveyors. They have offices at 211-217 West 125th St., New York City, and 20 Main St., Flushing, L. I.

The following changes have taken place in the U. S. Reclamation Service: Mr. H. S. Kleinschmidt, Assistant Engineer, Utah, has submitted his resignation from the service; Mr. Fred. A. Gorham has been appointed Engineering Aid and assigned to the Huntley Project, Mont.

Mr. Henry Rohwer, M. Am. Soc. C. E., formerly Chief Engineer and Consulting Engineer of the Missouri Pacific Railway, has opened an office at 1212 Chemical Building, St. Louis, Mo., for practice as a consulting engineer, making a specialty of railway, river improvement and sewerage work.

Mr. Paul Bigelow, District Manager of the New York Office of the Buckeye Engine Co., has been appointed agent for the New England District in addition to the New York territory. Mr. Wheelock Bigelow will be in charge of the Boston office of the company, located in the Oliver Building, Oliver St.

Mr. Takegoro Okada, Engineer to the Imperial Government Railways of Japan, and Mr. Hidero Kasuga, Secretary to the Financial Department of the railways (both of Tokio, Japan), are now visiting the United States for the purpose of investigating certain features of railway engineering and financial methods.

Mr. Elsworth M. Lee, Assoc. M. Am. Soc. C. E., formerly Chief Engineer of the Miller-Collins Co., Contracting Engineers, New York City, and Mr. George Hewitt, Assistant Engineer of the Passaic Steel Co., Paterson, N. J., have entered into a partnership, under the firm name of Lee & Hewitt, and opened offices at 234 Fifth Ave, New York City, to conduct a general consulting engineering practice.

Mr. Chas. T. Arkins, Mining Expert attached to the Seattle Office of the Allis-Chalmers Co., of Milwaukee, Wis., has been made Consulting Engineer to the Canadian Government. Mr. Arkins will act with the Chief of the Geological Survey of Canada and the Government Mining Department in an investigation of the merits of the extensive deposits of "white channel gravels," so-called, of Yukon Territory; and to report on the relative advantage of the mining and milling process over the sluicing treatment of these gravels for gold, which is the present method used.

Prof. Charles Lucke, of Columbia University, has been retained by the U. S. Department of Agriculture as expert to conduct investigations in the laboratories of Columbia University, in order to obtain data regarding the use of alcohol in small engines. The results of these tests will be published Jan. 1, 1907, in a bulletin, which will contain a record of all the work done in the subject both here and abroad, together with the conclusions to be drawn therefrom. Prof. Lucke would be pleased to receive any existing data on the subject, or information regarding the same, that our readers may happen to have or know of, as well as patents relating to alcohol engines. Those having vaporizers, carburetors or complete engines are invited to submit them for tests, which will be conducted free of charge, except that the transportation charges are to be born by the owner. Data and apparatus will be returned when the work is completed and due acknowledgment given for the assistance rendered.

Obituary.

Lucius A. Booth, one of the original incorporators of the Central Pacific R. R., died at Oakland, Cal., July 18, aged 86 years.

C. J. Ives, who was President of the Burlington, Cedar Rapids & Northern R. R., before its absorption by the Chicago, Burlington & Quincy Ry., died at Woodstock, Vt., July 18, aged 75 years.

Brig.-Gen. Edmund Rice, of the United States Army, died at his home in Wakefield, Mass., July 20. Mr. Rice was born in Massachusetts, Dec. 2, 1841, and served through the Civil War. He was the inventor of the Rice trowel and the Rice stacking swivel and knife intrenching bayonet now used by the army.

John Salter, Jr., President of the Otto Gas Engine Works of Philadelphia, Pa., died on July 12. He was a graduate of the Rensselaer Polytechnic Institute, of Troy, N. Y., class of '67. Upon graduation he accepted a position with an eastern railroad, later becoming City Engineer of Saratoga, N. Y. He was next employed by the Government of Equador, and in 1881 became manager of the Western Department of the Otto Gas Engine Works, being elected President of the company in 1889.

Adolf Ledebur, for thirty years professor of iron metallurgy at the Freiberg Mining Academy, Freiberg, Germany, died on June 7, 1906, at the age of 69 years. He was born at Blankenburg in the duchy of Braunschweig, in 1837. After a good preparatory education he obtained his metallurgical training as a state apprentice in the ducal iron works Zorge, supplementing this by a course in a technical college. From 1862 to 1875 he was engaged in blast-furnace and foundry practice, at Iisenburg, Berlin and Gröditz. In 1875 he was called to the chair of iron metallurgy at Freiberg, and he remained there until his recent death. He was a fruitful writer on subjects connected with the production of iron and steel, and was famous as the author of a number of treatises standard in German literature, most prominent among which perhaps is the "Handbuch der Eisenhüttenkunde." His work as teacher and as investigator, his thorough knowledge of the subject to which his life was devoted, together with a critical faculty which was of inestimable value in mastering the mass of facts and phenomena of the subject, placed him in the front rank of the workers in the field of iron and steel.

ENGINEERING SOCIETIES.

COMING MEETINGS.

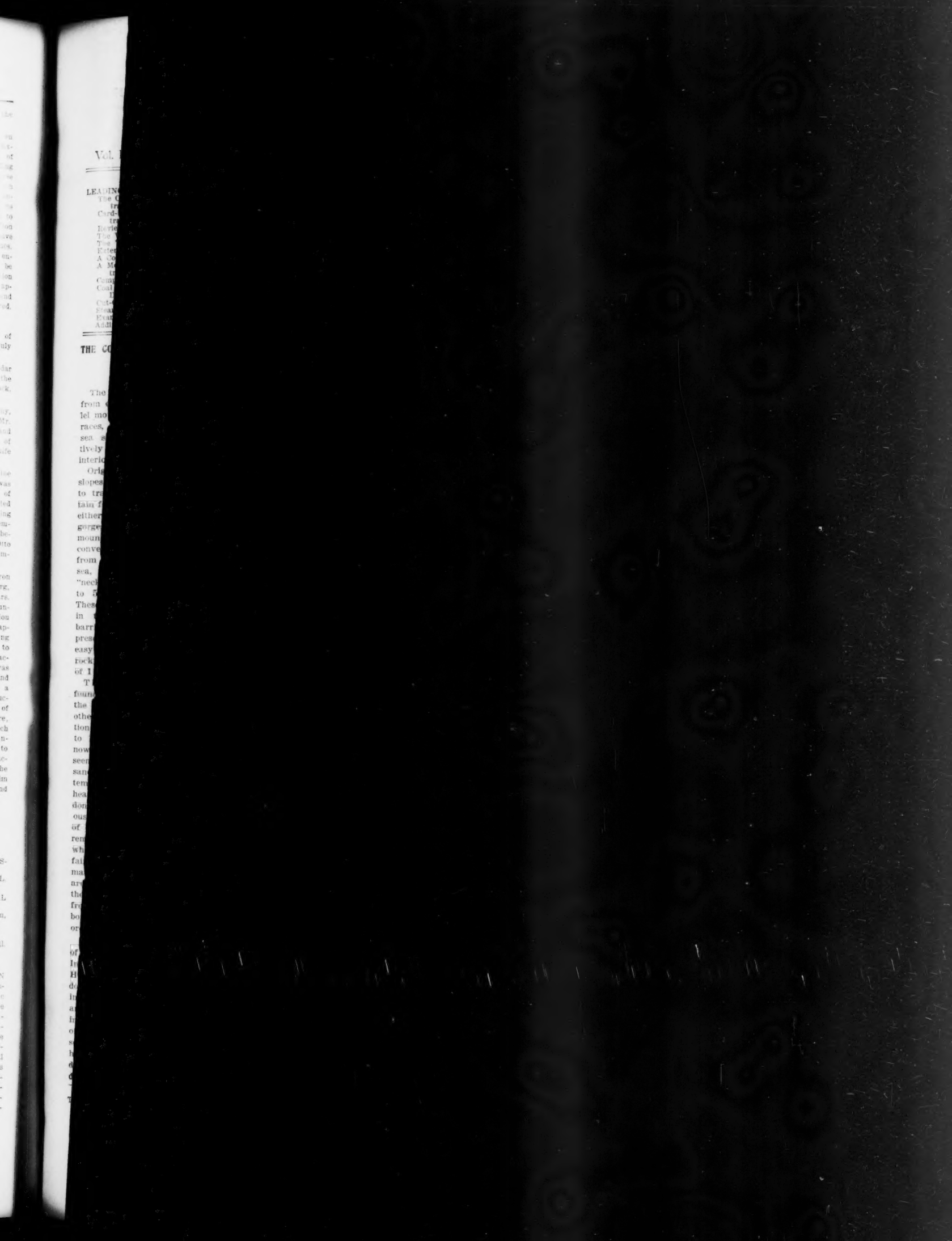
CONCRETE BLOCK MACHINE MANUFACTURERS' ASSOCIATION.

Aug. 8, 9. Annual meeting at Detroit. Secy., S. L. Wiltse, Jackson, Mich.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.

Aug. 15 to 17. Annual convention at New Haven, Conn. Secy., Frank P. Foster, Corning, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.

Sept. 26 to 28. Annual convention at Chicago, Ill. Secy., Jno. MacVicar, Des Moines, Ia.

NATIONAL ASSOCIATION OF GERMAN-AMERICAN TECHNOLOGISTS.—The 22d annual meeting of this association will be held at Baltimore, Md., and Atlantic City, N. J., on Sept. 1 to 5, 1906. At Baltimore the sessions of the association are to be at the Hotel Rennert. There will be two business sessions, on the mornings of Saturday, Sept. 1, and Monday, Sept. 3. The remainder of the time from Saturday to noon of Wednesday, Sept. 5, will be occupied with excursions, technical visits, a banquet, and a "commers." The convention is closed by a trip to Atlantic City on Wednesday afternoon, Sept. 5. Detailed information as to the arrangements may be obtained from the Corresponding Secretary, Mr. A. J. Loeser, 1902 Seventh St., Walbrook, Baltimore, Md.